POWER

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Don't Destroy Purchasing Power

A FRIEND sends us a clipping from his local paper in which a correspondent urges the maintenance of the purchasing power of the working classes as a means of averting depression and restoring prosperity.

If employers take advantage of an oversupply of labor to cut wages and lay off men by forcing more work from others, they reduce the number of potential customers for their product and diminish the purchasing power of each.

This means a reduction of the demand for the output of various industries, more people laid off, less money put into circulation, more unemployment, stagnation and deprivation.

Idle factories equipped to produce food and clothing, and people going hungry and ill-clad because they cannot work in the factories and produce what they need—this condition has been recognized by broad-minded industrialists, and the exploitation of the wage earner under the conditions of a cheap labor market has been condemned, deplored and discouraged.

The avaricious employer who seeks to swell his profits, or the ambitious executive who sees a chance to make a better showing in dividends by taking advantage of labor in difficulties, only chokes the main stream of his own and other's prosperity.

There are more goods bought with salaries and wages than there are with profits and dividends.

If all industries could keep on running at full time with full crews at full wages, there would be no hard times.

But a factory or a store cannot continue to run unless it can turn its wares into money, and it can do this only if there is somebody who feels the need of them and has the means to pay for them.

Money can be spent to no better advantage at a time like this, nor can better advantage be taken of the period of lessened activity, than by putting equipment in order for the restoration of normal operation, which is sure to come.

EDITORIALS

A Ray of Sunshine In Hydro's Field

THERE is every indication that the purchasers of hydro power machinery have sincerely deplored the competitive antagonism among some of the important manufacturers of water-power machinery. For years the rivalry has been extreme and the industry has been kept poor by the willingness of one concern or another to accept less than a legitimate profit for its work. Prices have at times been below the cost of production.

The effect has been to create a feeling of self pity on the part of the manufacturer and a tendency to blame purchasing methods. The purchaser, on the other hand, generally recognizes the unhealthy conditions, deplores them, and perforce accepts the lowest consistent price.

Consequently, it is pleasing to all well wishers of the industry that a coalition of interests with the purchaser's consent has resulted in two rival companies burying their competitive hatchets and merging their patent interests so each may build a half of one of the most important hydro power plants of recent years.

While the merging of designs by rival companies has previously been done in a few notable cases, this latest move is none the less pleasing to those who have both the purchaser's and the manufacturer's interests at heart. The spirit of the transaction is worthy of cultivation, since it contains the germ of life for a highly important branch of American industry.

Mixed-Pressure Turbine Or Spare Boiler?

WHEN an industrial plant management faces the necessity of enlarging its power facilities it must decide whether merely to add to an existing low-pressure plant or to take advantage of the better efficiencies obtainable through the use of moderately high pressures.

One of the alleged objections to making a high-pressure addition to a low-pressure power house is that failure of boiler or turbine will result in a complete loss of the new capacity; whereas if a low-pressure installation were made the new turbine could be operated on spare low-pressure boiler capacity, even though the new boiler were shut down. Thus for equal reliability the high-pressure addition should contain a spare boiler, which is apt to prove more expensive than the improvement in economy can justify.

An article in this number describes how this disadvantage was overcome by installing a mixed-pressure turbine designed so that practically full load can be carried when supplied with low-pressure steam from spare low-pressure boilers. In this way the improvement in efficiency due to high pressure is obtained whenever the new boiler and turbine are available, and at the same time outage of the new boiler will not prevent the high-pressure turbine from operating.

Mixed-pressure turbines such as these must be "tailor made" and they require the closet co-operation between manufacturer and the engineer representing the industrial concern. That such co-operation takes place is highly commendable.

Large-Capacity Airless-Injection Diesels

WHILE this country has shown a marked leadership in the production of airless-, or solid-injection, oil engines, the cylinder sizes have in the past been held to a maximum of about twenty-two-inch bore. Even moderate ratings have been obtained by multiplication of cylinders.

Various tests at Langley Field have revealed that, regardless of the pump pressure, an oil-spray penetration of over eight inches is impossible. This apparently precluded a cylinder bore of over sixteen inches and designers have more or less resigned themselves to this limitation and have proceeded to perfect the mechanical details of small cylinders. In fact, most of those de-

signers who essayed more liberal cylinder dimensions did not dare attempt to burn the oil directly within the cylinder, but adopted the separate combustion chambers, of less generous proportions.

European designers were equally as appreciative of the limitations of oil spray penetration, and, to bring the mountain to Mohammed, set about to devise methods of forcing the air charge to the oil spray.

These attempts have been successful up to about thirty-inch cylinder bore; consequently, European developments have been almost exclusively in airless-injection engines of this bore or less. To obtain high output the cylinders have been made double-acting.

Recently American builders have obtained licenses to use several of these systems, and it is to their credit that at least one builder has had the courage to construct such cylinders with a thirty-two-inch bore and a forty-two-inch piston stroke. These single-acting cylinders are rated at over six hundred brake horsepower, which makes possible units of as high as ten thousand horsepower. If construction costs compared to air-injection engines can be reduced, there is reason to expect a real activity in the installation of large diesel engines.

The Future Of Marine Steam Power

FROM ONE Indian at the end of a paddle to two hundred thousand horsepower on the propeller shafts of a single ship is a far cry. The new mark will be attained by the turbines of a giant Cunarder for which the contract has just been let, as reported elsewhere in this number.

On land this plant would be rated as a large central station. It brings again to mind the future of marine steam plants in such matters as size, pressure and type of firing.

Nothing is impossible, but it seems improbable that the power plant of a single ship will ever equal the capacity of the largest land plant. In certain other respects, also, the tendency at sea is to follow, rather than lead, land practice.

Two important examples are found in pulverized coal and high pressures. After being well established ashore for nearly ten years, pulverized coal is finally gaining headway as a method of firing marine boilers. Competing with oil, it has the handicap of a more bulky fuel, but this, on many routes, is not enough to offset the saving in fuel cost.

Pressures for ships' turbines are gradually working up, but the marine engineer still looks upon 500 pounds as a very high pressure, while his friends ashore are working commercially with 1,200 and 1,400 pounds. Yet it would appear, offhand, that 1,400 pounds pressure has an even greater justification aboard ship than on land. The ship can show equal savings in fuel, and, in addition, can capitalize the space and tonnage thus released for pay load.

Marine engineers have been, and properly, conservative, because of the extreme seriousness of shutdowns at sea. However, the development of pulverized coal and high pressures on land has reached the stage where the factor of reliability hardly enters into the choice. The road is open for the rapid extension of marine applications.

Don't Forget Piping Repair Costs

PIPING INSTALLATIONS, to give maximum of service per dollar invested, must use materials best suited to each application. This requires rigidly drawn specifications to insure that material other than that intended is not to be used. Loosely written statements leave loopholes for substitutes. And when the specifications have been properly drawn they still must be supported by rigid inspection during installation.

The cost of replacement is an important factor in pipe selection, but one that is too frequently ignored. In a building only twenty years old a partial piping replacement job recently cost fifteen hundred dollars, whereas, in the original installation, the additional cost of the proper pipe would have been less than one hundred dollars. When pipes are installed behind walls or in other inaccessible places where they are expensive to repair, only materials should be selected that are known to be permanent for the service. If the pipe is readily accessible, there may be some justification for taking a reasonable chance on the material used, but not where the renewal cost may be several times the original.

Care must be taken to have the material that is specified installed throughout. If a certain grade of pipe is required, only this material should be allowed. One piece of inferior pipe in a line or an inferior fitting will limit the service of the whole line to that of the cheaper material.

Repair bills are not the only reason for extreme care in selecting and installing pipe. Some of them do, however, emphasize the fact that there are sound economic reasons for giving piping the same careful engineering attention as the other equipment.

POWER *Stands for . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Another PAPER MILL Employs 600-LB. Steam

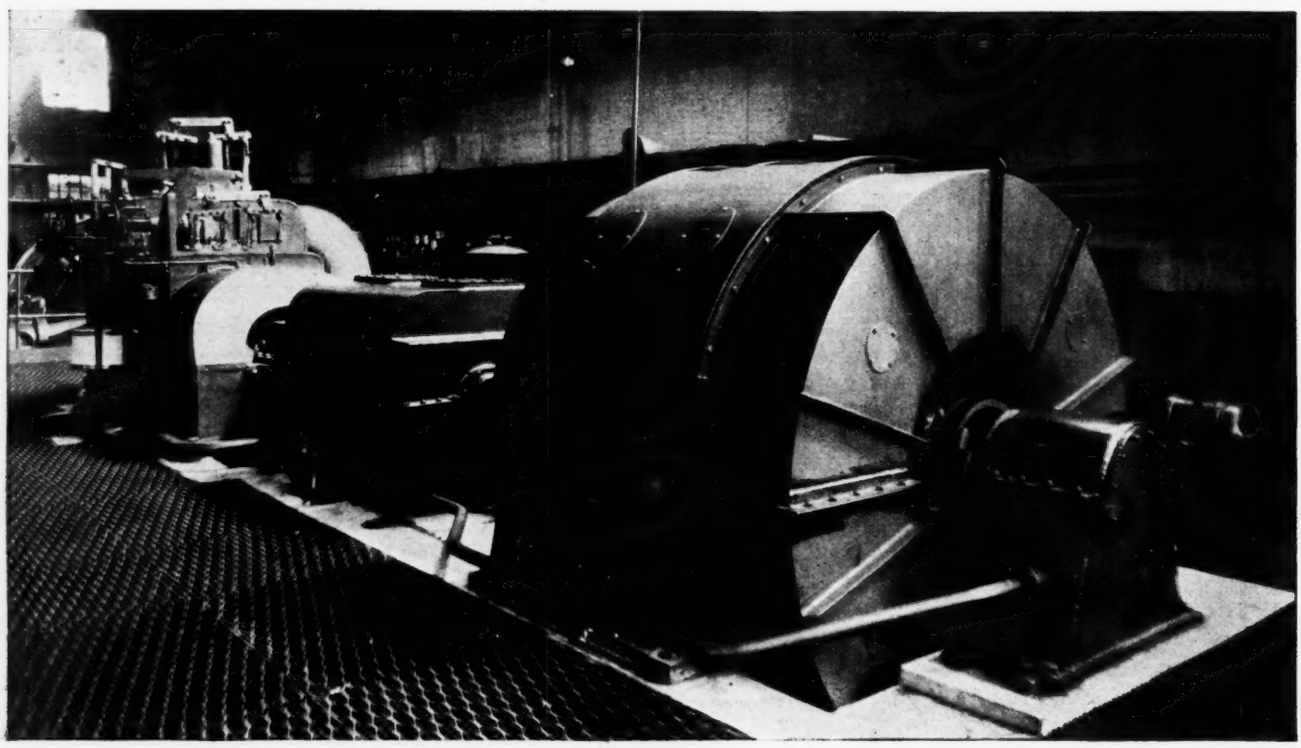
By E. H. BARRY
Power Engineer
West Virginia Pulp and Paper Company

The West Virginia Pulp & Paper Company recently placed in service a new power plant at Tyrone, Pa., which consists of a new boiler house containing two 8,460-sq.ft., 600-lb. boiler units, together with their auxiliaries; a new feed-water treating plant and a 5,000-kva. non-condensing bleeder turbine-generator.

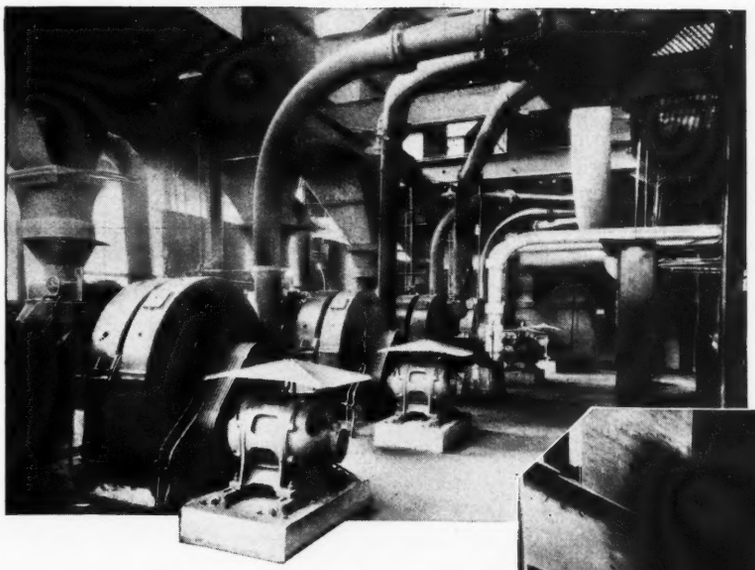
PRIOR to the installation of the new plant, the Tyrone mill was operated with 180-lb. steam produced in eight boilers supplemented with steam from waste-heat boilers. Inasmuch as the old plant operated continuously at nearly peak capacity, additional power units were demanded to provide reserve equipment.

Decision in favor of 600 lb. for the new plant was made as a result of extensive studies wherein the economics of various pressures and turbine combinations were considered. A pressure somewhat higher than 600 lb. could have been selected advantageously, but this would have involved reheating the steam after partial expansion through the turbine. It was felt, however, that the additional complications would more than offset the increased economy to be gained from the higher pressure.

To make the present layout better understood, a description will be given of the old power plant. Steam at 180 lb. was generated in two boiler houses, in one of which were four straight inclined-tube boilers of 535 sq.ft. each. These were fired by single-retort stokers. The boiler house was in the midst of the mill buildings



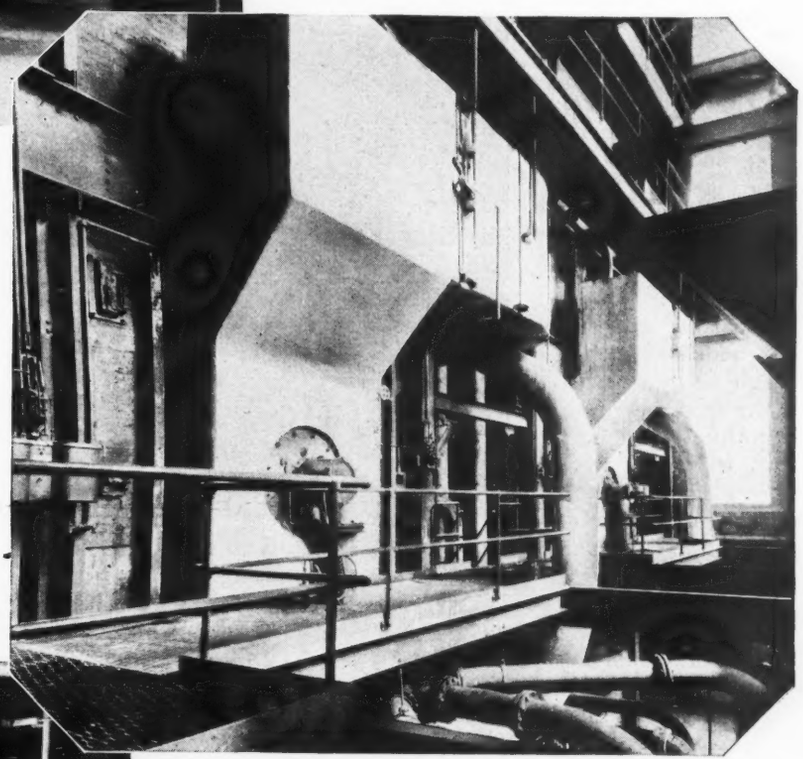
7,000-KVA. GEARED TURBINE-GENERATOR,
showing the multiple valves on both the high- and low-pressure steam chests and the back-pressure regulator. Steam enters the throttle of this turbine at 600 lb. 700 deg. F. and exhausts at 180 and 20 lb.



ABOVE—THIS VIEW SHOWS THE ARRANGEMENT OF PULVERIZERS AND COAL PIPING TO THE BURNERS

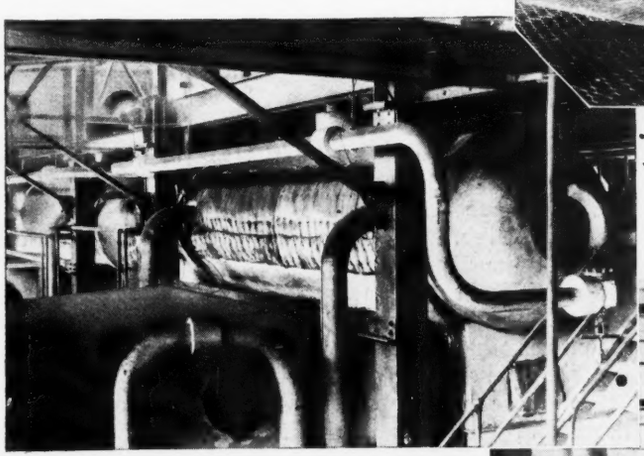
BELOW—FRONT OF THE BOILERS AT THE BURNER LEVEL

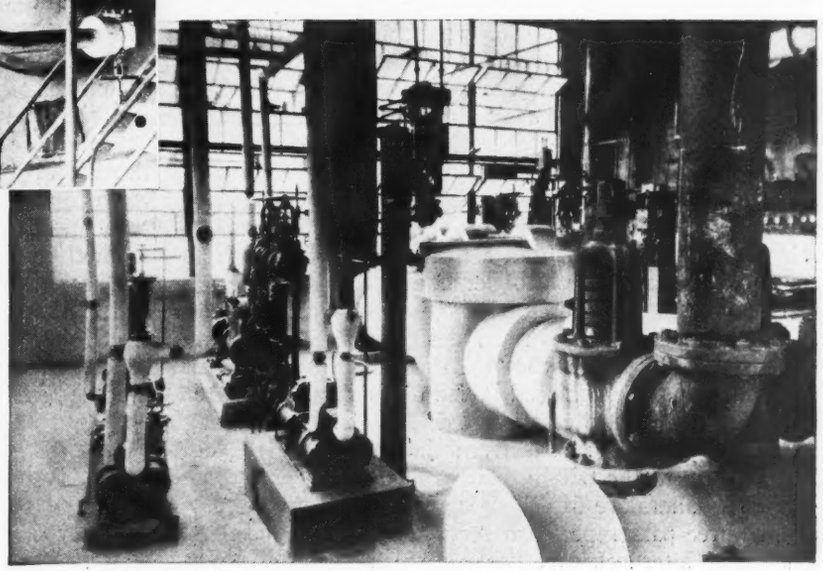
An interesting feature in connection with the automatic combustion control is shown in the arrangement of dampers in the hot-air duct. The pipe shown leading from the duct between the dampers communicates with the pressure regulator shown at the extreme left, which operates to hold a constant pressure ahead of the damper nearest the burner, which damper is equipped with an integrating device.



BELOW—DRUMS OF THE 600-LB. BOILERS

Note the blanket insulation on the rear side of the drums, which is removable for the purpose of inspecting the longitudinal riveted seam.





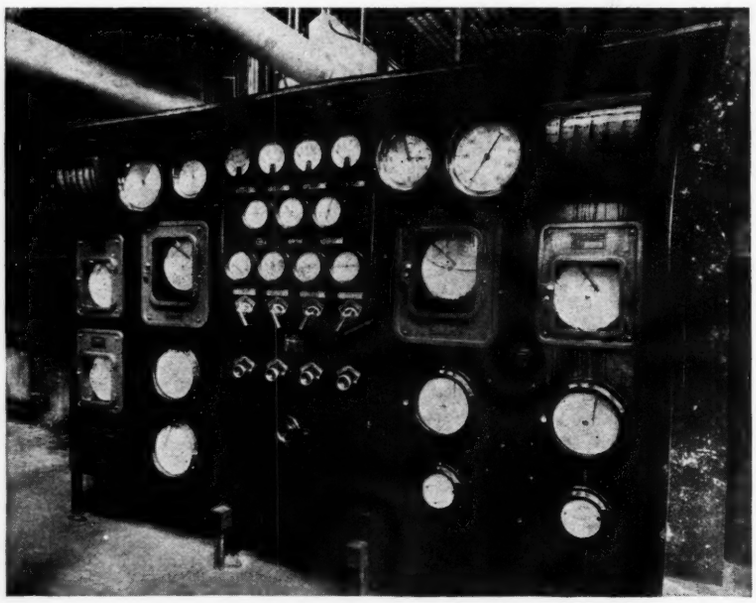
RIGHT—VIEW OF VALVE HOUSE

The apparatus seen includes 600 lb. reducing valves, desuperheater, pressure and temperature regulators, pumps in duplicate for supplying operating oil for reducing valves, and water for desuperheating. The relief valves in the foreground are mounted on the 180 lb. header.

and they suffered from the discharge of cinders from the short steel stacks. Because of the age of the boilers and the condition of the auxiliary equipment, this boiler house was close to the end of its useful life.

The second boiler house was of modern design, having been constructed in 1918. It contained four 6,920-sq.ft. straight, inclined-tube, long-drum boilers generating steam at 180 lb. pressure. There was an overhead concrete bunker, and the boilers were fired by underfeed stokers with forced-draft fan equipment and were served by a radial brick stack 235 ft. high. This boiler house contained an open feed-water heater, boiler feed pumps, forced-draft fans and coal- and ash-conveying equipment of modern type.

The old power house contained one non-condensing turbine unit of 1,563 kva. capacity and two bleeder units, one of 1,563 kva. and the other of 3,125 kva. capacity. In addition to the turbine-generator units there were four reciprocating engines, two of which were direct connected to alternating - current generators and served as reserves; the other two engines drove direct-current generators supplying current for the electrolytic bleach plant. In addition, the power house contained several auxiliary units, such as air compressors and lighting sets. All of the steam-driven units in the power house operated with 180-lb. steam, a large portion of which was bled or exhausted at 20 lb. pressure for use in process. The alternating-current electrical equipment was built for 3-phase, 25-cycle current, the generator voltage being 480. All of the power consumed at the mill was generated at the plant, there being no outside connection with any other source. Continuity of operation was important.



PANELBOARD IN THE NEW BOILER HOUSE

Automatic combustion control is mounted on the central panel. The right and left panels contain instruments which record data pertaining to the individual boilers as well as totalizing steam meters, recording pressure and temperature gages.

A small amount of steam was made in waste-heat boilers supplied with gases from rotary incinerators. These have continued in operation since the erection of the new power plant.

After selecting 600 lb. as the operating pressure for the new boilers, it was decided to install two steam generating units at this time and a third later. Inasmuch as the newer of the two old boiler houses was still in first-class condition and contained a satisfactory coal bunker, the new boiler house was so designed as to form an extension to it. Later when the third high-pressure unit is installed it will be placed in the old boiler house after removing one or two of the 180-lb. boilers. A traveling weigh larry conveys coal from the bunker in the old boiler house to the 600-lb. boilers in the new extension. The new boilers are of the straight, inclined-tube, cross-drum, three-pass type, with sectional cast-steel headers. They have interdeck superheaters which deliver steam at a total temperature of about 750 deg. F. The furnaces are water-cooled on three sides, the front wall being of suspended brick construction with space for air ventilation.

A unit system of pulverized-coal firing is employed, with one burner of the turbulent type in the front wall of each furnace. The impact pulverizers receive coal from the traveling weigh larry. Two pulverizers are directly connected with each furnace, a fifth pulverizer, acting as a spare, is so arranged that it can supply coal to either of the two furnaces or to both as may be required. To effect proper mixing of the coal from the various pulverizers, a special collecting fitting is employed, with three inlets connecting with individual pulverizers, each inlet pipe having a coal valve. The leaving side of the distributing fitting connects directly with the burner. It is thus possible to operate either boiler with one, two or three pulverizers, or both boilers can be operated simultaneously with five pulverizers if conditions warrant.

Gases, after leaving the boilers, enter air preheaters of the regenerative type, after which they are conducted to the stack which formerly served the old boiler house.

The two water-cooled side walls converge at the bottom to form a 60-deg. slope. Cast-iron plates are bolted on to the side-wall tubes on the sloping bottom, thus forming a smooth inclined floor on which the ash slides down into the ashpit, located below the throat of the hopper bottom. The ashpit is 6 ft. wide, while the width of the hopper throat is 3 ft. 2 in.; thus most of the ashpit is in the shadow of the water-cooled hopper bottom. With this arrangement the ash accumulating in the pit remains solid and granular, permitting its removal while the boilers are in operation.

Ashes are raked through doors in the side walls of the ashpit, whence they are discharged into a pneumatic conveyor that delivers into a collecting tank, which, in turn, discharges directly into railroad cars for removal from the plant.

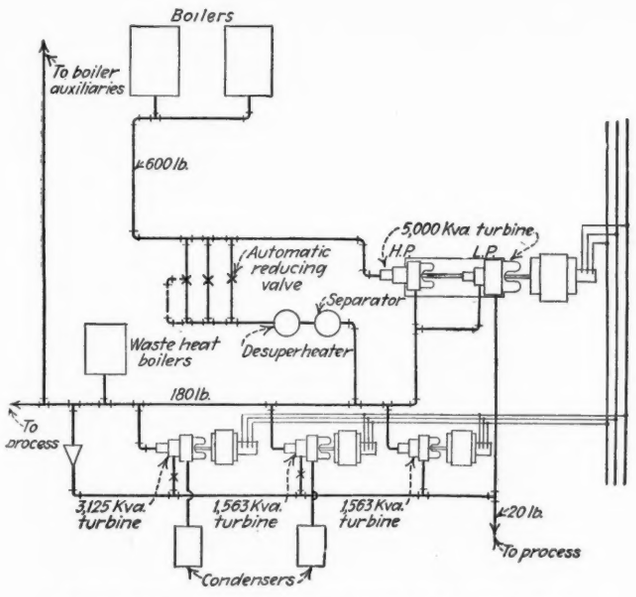
The power house is approximately 800 ft. from the boiler house, and the long high-pressure pipe line has electrically welded connections except at the expansion bends, where Van Stone flanges are used. Eleven bends are used in the entire line.

High-Pressure Turbine

The turbine-generator, of Westinghouse geared design, possesses some novel features. It is rated at 5,000 kva., 25 cycles, 3 phases, 480 volts, and is non-condensing, taking 550-lb. steam at the throttle, exhausting

part of the steam at 180 lb. and the balance at 20 lb. pressure. Two steam chests are incorporated in the turbine housing. The high-pressure steam chest contains the admission valves under the control of the speed governor. The low-pressure steam chest contains valves controlled by the pressure in the 20-lb. exhaust line. Thus the turbine will handle its electrical load and at the same time satisfy the demand for 20-lb. steam. Any surplus steam is discharged into the 180-lb. system. A system of reducing valves and a desuperheater serves to maintain constant pressure and temperature in the 180-lb. system. If insufficient steam at 180 lb pressure is exhausted from the high-pressure turbine, the reducing valves come into play and make up the deficiency. Since the high-pressure steam is at a temperature above the limit which the low-pressure turbines can withstand, desuperheating is necessary when high-pressure steam is taken through the reducing valves. Condensate is pumped into the desuperheater in proportion to the flow of steam through the reducing valves. Regulation of the amount of water used for desuperheating is obtained through the use of special apparatus designed for the purpose. It was necessary to construct an addition to the power house for the reducing valves, desuperheater and other auxiliaries. The reducing valves are oil-operated, and one service and one spare oil pump are located in the valve room. Two water pumps, one of which is a spare serving the desuperheater, also are in this room.

The governor of the high-pressure turbine is equipped with a compensator, the purpose of which is to restore



Steam hook-up for generating unit and process lines

the turbine speed to normal after a speed change resulting from a change in load. As a result of its use, the turbine speed, and, hence, the frequency, is held constant in spite of wide variations in electrical load and in demands for steam from the turbine at both 20 and 180 lb. Nearly all of the power generated at the plant is so-called "byproduct," that is, power generated by process steam in expanding from 600 lb. down to process pressure. The balance of the mill power load is generated by one of the bleeder turbines.

Since the installation of the new plant the two reciprocating engines connected to the reserve alternating-current generators have been removed and likewise one of the reciprocating engines driving a direct-current generator has been dismantled. The fourth reciprocating engine is held as a reserve unit to supply direct current to the bleach plant. The latter department now gets its direct current from two motor-generator sets.

Since all of the steam both for process and for the generation of power is generated at 600 lb. in two boiler units, total demand for steam fluctuates between wide limits, and it was decided to equip the boilers with automatic combustion control to prevent extreme variations in boiler pressure as well as to maintain the proper ratio between air and fuel at all times. Each furnace is maintained at a constant suction by means of an automatic regulator operating on the uptake damper. Fuel and air are fed in the correct proportions by compressed-air regulators governed by a master regulator receiving its impulse from the pressure in the 600-lb. header. In operation, a drop in steam pressure automatically serves to increase both fuel and air, at the same time maintaining the correct fuel-to-air ratio. Variations in the furnace suction due to changes in the amount of fuel and air supplied to the furnace are compensated for by the automatic furnace suction regulator operating on the uptake damper.

Operating Conditions

Some operating data may prove of interest. The temperature of the water in the boilers averages 488 deg. F.; that of the superheated steam is 750 deg. Combustion air leaves the preheater at approximately 550 deg. and enters the furnace at this temperature. Gases leave the boiler at 600 deg. and after passing through air preheaters enter the stack at approximately 300 deg. F. The highest rating which has so far been obtained from the boilers is 100,000 lb. of steam per hour. At this rating a little over 10,000 lb. of coal per hour is fed to each boiler. Since the heat value of the coal is in the neighborhood of 14,000 B.t.u., each burner has supplied heat to the furnace at the rate of more than 140,000,000 B.t.u. per hour. It has been claimed that this constitutes a record for heat released by a single turbulent-type pulverized-coal burner. Only one burner is used in each furnace because the furnace width did not permit of two burners being placed side by side, the width being limited by the column spacing of the old boiler house, where it is contemplated to install the third unit. Two turbulent-type burners could not have been installed one above the other without unduly increasing the height of the furnace, which was not desirable.

So far no trouble has been experienced from wet steam. The concentration of dissolved and suspended solids in the boiler water is kept below a predetermined maximum figure by means of continuous blowoff. Internal steam separators are also inserted in the boiler drums on the steam outlet nozzles. Heat in the blowoff water, which would otherwise be wasted, is transferred to the incoming feed water through a heat exchanger.

Approximately one-half of the total boiler feed is made up of condensate returns from the power plant and from the process. The other half is raw water pumped from the river. It first passes through a condenser at the power house, after which it enters a sedimentation tank, where alum and alkali are introduced for the purpose of forming a floc to assist in the sedimentation of suspended solids. From the sedimentation tank the hot make-up water is pumped through pressure sand filters and then

Principal Equipment at Tyrone Mill

Boiler Equipment

Boilers, two cross-drum, 600 lb. pressure, 8,460 sq.ft. each ..... Springfield Boiler Co.
Superheaters, single-pass, bare-tube, interdeck, for 750 deg. F. total temperature ..... Foster Wheeler Corp.
Furnaces, two, 8,670 cu.ft., with water-cooled side and rear walls ..... Foster Wheeler Corp.
Furnace wall front, air-cooled ..... M. H. Detrick Co.
Soot blowers ..... Diamond Power Specialty Corp.
Air preheaters, two, to raise temperature of air to 550 deg. F. ..... Air Preheater Corp.
Feed-water regulators ..... (Copes) Northern Equipment Co.
Water columns ..... Reliance Gauge Column Co.
Safety valves ..... Consolidated, Ashcroft, Hancock Co.
Blowoff valves ..... Yarnall-Waring Co.
Non-return valves ..... Elliott Co.
Boiler feed pumps ..... (Cameron) Ingersoll-Rand Co.
Auxiliary turbines ..... Terry Steam Turbine Co.
Forced- and induced-draft fans ..... Green Fuel Economizer Co.
Ash removal ..... Girtanner Engineering Corp.

Fuel Equipment

Coal crusher ..... A-A Crusher & Pulverizer Co.
Combustion control ..... Hagan Corp.
Pulverizers ..... Riley Stoker Corp.
Burners ..... Riley Stoker Corp.
Weigh larry ..... Freeman-Riff Co.

Turbine Equipment

Turbine-generator, one 4,500-kw., non-condensing, extracting steam at 180-lb. gage and exhausting at 20-lb. gage, 25-cycle, 480-volt, 3-phase ..... Westinghouse Elec. & Mfg. Co.
Desuperheater ..... Elliott Co.
Reducing valves ..... Smoot Engineering Corp.
Temperature control ..... Smoot Engineering Corp.
Steam separator ..... Swartwout Co.
Switchboard ..... Westinghouse Elec. & Mfg. Co.
Pumps for desuperheater and reducing valves ..... Dean Bros.
Storage batteries ..... Electric Storage Battery Co.
Motor-generator sets ..... Elliott Co.
Turbine non-return valves ..... Schutte & Koerting Co.
Low-pressure expansion joints ..... E. B. Badger & Sons Co.

Feed-Water Treating and Heating

Water treatment ..... Hall Laboratories, Inc.
Water softeners ..... Permutit Co.
Water filters, sedimentation tank, sand filters and chemical feed ..... W. B. Scaife & Sons Co.
Continuous blowoff system of heat exchanger ..... Permutit Co.

Piping and Valves

High-pressure steam and water piping ..... Grinnell Co.
High-pressure valves ..... Walworth Co.
Valves for soot blowers ..... Consolidated, Ashcroft, Hancock Co.
Insulation ..... Nicely & Co.

Instruments

Pressure gages ..... Ashton Valve Co.
Draft gages ..... Bailey Meter Co.
Feed-water meters ..... Simplex Meter Co.
Boiler meters ..... Bailey Meter Co.
Temperature recorders ..... Bailey Meter Co.
Steam-flow meters ..... Republic Flow Meters Co.
Pressure recorders ..... Foxboro Co.
Temperature recorders ..... Foxboro Co.

Miscellaneous

Motors ..... Westinghouse Elec. & Mfg. Co.
Steel, fabrication and erection ..... F. M. Weaver & Co. Inc.

through zeolite softeners, after which it enters a hot-water storage tank mounted above the open feed-water heater. A temperature of 212 deg. is maintained in the feed-water heater, and steam is constantly vented from the heater to eliminate oxygen from the feed water. The Hall system is used for final conditioning of the boiler water, phosphate being added by gravity feed to the open heater.

The forced- and induced-draft fans, and also the spare coal pulverizer, are driven by steam turbines which exhaust into the feed-water heater. The four pulverizers in active service are driven by induction motors.

The drums of the high-pressure boilers are approximately 19 ft. long and 54 in. in diameter. They are made of a single sheet of boiler plate $2\frac{3}{16}$ in. thick, hot-rolled, and were formed when hot. The seam is of riveted construction with inner and outer butt strap. Inside reinforcing plates are riveted to the drum where the circulating tubes enter. The volume of the drum is 1,222 cu.ft. Assuming that half of the drum volume is steam-releasing space, at maximum rating a release of nearly 164 lb. of steam per hour per cubic foot of steam space in the drum takes place. The water-wall tubes are $3\frac{1}{4}$ in. in diameter and spaced on $6\frac{1}{2}$-in. centers on both sides and back walls. A single layer of specially shaped tile which conforms to the shape of the tubes is laid back of the water-wall tubes. Back of the tile there is one layer of high-temperature insulation; next a single layer of low-temperature insulation, and the entire outside surface of the walls is covered with a sheet metal casing.

The new power plant was placed in operation without disturbing the continuity of mill production in the slightest. After the boilers were brought up to pressure, steam was allowed to flow through the high-pressure reducing valves in the power house and firing was reduced under the old boilers. The high-pressure turbine was brought up to speed and load gradually placed on it while at the same time load was removed from two of the low-pressure turbines.

Although some troubles have been experienced, none has been serious, and in general the plant has fulfilled expectations. A similar plant is in the process of construction at the company's mill at Piedmont, W. Va.

Use of Electricity Increasing In British South Africa

THE USE of electricity both for industrial purposes and in the home is showing a steady increase in the Union of South Africa, according to Assistant Trade Commissioner E. B. Lawson in a bulletin just released by the United States Department of Commerce.

This increase, it is pointed out, has been reflected in increased shipments of electrical goods from the United States. Last year total American exports of this class had a value of approximately $2,000,000, which was four times the figure registered in 1922.

The report shows a consistent increase in the amount of electric current generated in the Union by the 150 or more central stations, alternating-current consumption showing the greater gains. The importance of ample supplies of electricity, the report declares, was recognized by the authorities several years ago by the passage of an electricity act, by virtue of which the regulation of electric power projects is more or less centered in two government bodies.

Industrial developments in the Union, since definite steps were taken to foster the operation of local factories, have resulted in increased demand for electric motive power. During the past fifteen years the number of plants using electricity has more than doubled, these now numbering 3,000.

Tests for Comparing

HEAT INSULATING MATERIALS

By EUGENE F. ZEINER
The Philip Carey Company

MODERN INDUSTRY requires that suitable insulating materials be provided for temperatures from 1,600 to 1,800 deg F. The fact that the physical characteristics of the raw materials from which heat insulation is constructed change under varying conditions of temperature, and because one type of insulation may be efficient within a relatively narrow temperature range but extremly inefficient at higher temperatures, are reasons why no one insulation can be employed for this entire range of temperature with uniform satisfaction.

There are a number of definite requirements that an insulating material should meet to be considered satisfactory These requirements are, in order of importance:

1. *Insulating Efficiency*, assuring proper performance of equipment covered, and low operating and production costs.

2. *Durability*, which includes: (*a*) Sufficient structural strength to permit shipping, handling and application without excessive breakage; (*b*) ability to withstand the decomposing effects of continuous exposure to high temperature; (*c*) low heat shrinkage; (*d*) sufficient mechanical strength and toughness to withstand handling and reapplication after exposure to high temperatures; and (*e*) resistance to the effects of moisture.

The actual selection of proper insulation and the type of insulation that should be used for a particular condition is a matter of economic study Such a study requires a careful consideration of insulating efficiency, life of installation, first cost of material or material "in place."

To make an intelligent choice of suitable insulating materials there must be a uniform basis for comparing different types of insulating products, and different brands of the same type of insulation. The basis of comparison between types is that of actual or specific conductivity, that is, the relative resistance that an insulating material of a certain type offers to the transmission of heat. This characteristic is most clearly and easily shown by a conductivity curve. Such curves are plotted using mean temperature as abscissa and heat transmission in B.t.u. per square foot of surface per hour per degree temperature difference per inch thickness as ordinate. Mean temperature is generally recognized as the most universal basis on which to interpret conductivity.

For previous articles see Sept. 16 and Oct. 7 numbers.

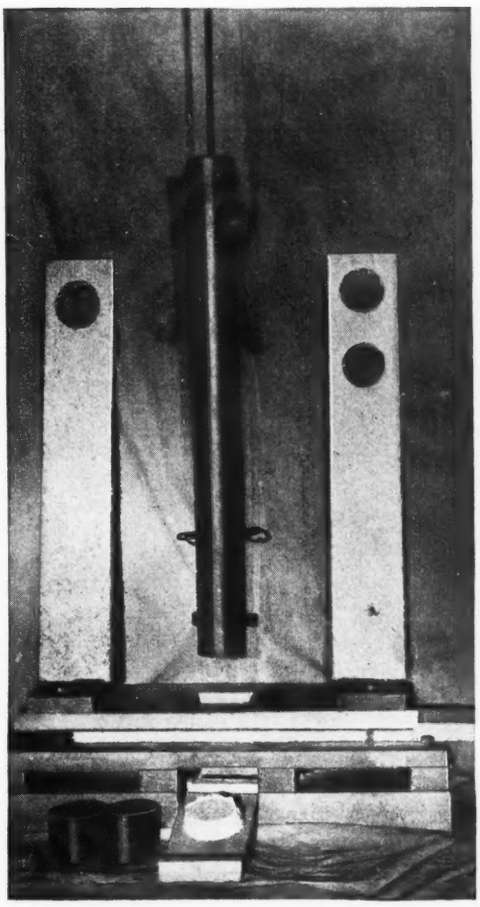


Fig. 1—Apparatus for making impact test

This is the third article of a series on heat insulation. It deals with methods of determining the mechanical characteristics of commercial types of insulation available

Various brands of each type of modern insulation have been tested and the conductivity curve of each product accurately determined. Examples of such curves are shown in Fig. 2.

Many engineers prefer to consider the merit of a product, whether it be a centrifugal pump or a piece of pipe covering, in terms of efficiency. To determine the efficiency of an insulation it is necessary to know, first, the amount of heat that a bare, or unisulated, pipe would dissipate under certain conditions, and, secondly, the amount of heat that would be transmitted through an insulation installed on the same sized pipe under the same conditions. Table I, showing bare pipe heat losses, is taken from an A.S.M.E. paper by R. H. Heilman.

Having the bare pipe loss under a particular condition, and the heat transmission through an insulation, the efficiency of the covering is determined as follows:

$$\textit{Per cent efficiency of insul.} = \frac{\textit{Heat saved}}{\textit{Bare pipe loss}} = \frac{\textit{Bare pipe loss} - \textit{Surf. ins. loss}}{\textit{Bare pipe loss}} \times 100$$

Various types of mechanical tests have been employed to indicate the service that can be expected from molded insulation. A

TABLE I—HEAT LOSS FROM BARE IRON PIPE IN B.T.U. PER LINEAL FOOT PER HOUR

Pipe Size, In.	Temperature Difference, Deg. F., Between Pipe and Air														
	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900
2	354.5	488.3	643.8	825.1	1,035	1,276	1,549	1,851	2,179	2,547	2,948	3,382	3,851	4,357	4,893
2½	418.6	576.0	761.3	977.8	1,232	1,521	1,849	2,203	2,611	3,054	3,536	4,061	4,626	5,236	5,882
3	500.7	687.7	910.6	1,171	1,478	1,828	2,223	2,653	3,142	3,690	4,275	4,690	5,597	6,337	7,122
3½	563.3	777.4	1,027	1,323	1,667	2,063	2,513	3,006	3,562	4,185	4,852	5,575	6,357	7,200	8,094
4	627.2	866.5	1,146	1,477	1,863	2,308	2,812	3,365	3,990	4,683	5,430	6,243	7,121	8,067	9,076
4½	689.0	956.3	1,265	1,632	2,054	2,547	3,105	3,725	4,417	5,169	5,980	6,916	7,891	8,941	10,060
6	899.2	1,250	1,656	2,144	2,701	3,344	4,071	4,888	5,802	6,793	7,887	9,075	10,360	11,740	13,220
8	1,158	1,606	2,131	2,762	3,493	4,326	5,270	6,332	7,505	8,807	10,230	11,770	13,450	15,250	17,160
10	1,433	1,988	2,639	3,421	4,331	5,368	6,542	7,862	9,306	10,940	12,710	14,630	16,710	18,960	21,340
12	1,685	2,305	3,110	4,038	5,096	6,320	7,707	9,286	11,000	12,911	15,000	17,280	19,740	22,400	25,220
14	1,832	2,546	3,382	4,392	5,553	6,890	8,406	10,130	12,000	14,100	16,380	18,870	21,570	24,470	27,560
16	2,075	2,887	3,841	4,994	6,309	7,814	9,560	11,480	13,660	16,050	18,660	21,490	24,570	27,882	31,400
18	2,330	3,243	4,316	5,597	7,076	8,787	10,731	12,928	15,340	18,030	20,970	24,160	27,620	31,354	35,320
Flat (per sq.ft.)	470.0	652.5	870.0	1,127	1,424	1,768	2,160	2,601	3,090	3,633	4,228	4,868	5,560	6,324	7,119

test that has been used extensively in the past to determine this important factor has been the transverse loading test. In performing it two knife edges spaced, usually, 10 in. apart are used to support the test block. The load is gradually applied at the center of the 10-in. span, until the test piece fails.

The transverse test alone does not give all the information necessary to determine the durability characteristics of a molded insulation Those who handle insulating products know that brittleness, or the tendency to crack and break under suddenly applied stresses caused by dropping a piece of insulating material or having something strike it suddenly, is one of its most important mechanical characteristics. The transverse test does not tell this part of the story, because the load is gradually applied. Therefore to secure more information regarding durability a machine such as is shown in Fig. 1 might be used.

With this test apparatus weights are dropped measured distances upon a test specimen and the work necessary for the breakdown is measured in foot-pounds of impact resistance. The comparative results of tests on different makes of insulation give their relative toughness, or resistance, to breakage through sudden shock or impact.

The relative values of three brands of 85 per cent magnesia tested for transverse strength and for impact resistance are shown in Table II.

TABLE II—STRENGTH CHARACTERISTICS OF 85 PER CENT MAGNESIA

Material	Transverse Strength, Pounds	Impact Resistance, Foot-Pounds	Penetration 5 Kg. Load, Mm.
1	43.5	60.5	8.9
2	43	50	10.2
3	42.5	26.5	10.0

Certain classes of service require a material that will not become unduly soft in service. For instance, a soft 85 per cent magnesia installed on a pipe subject to vibration will gradually break down and powder. This change will, very likely, result in the creation of a space between the bottom of the pipe and the lower half of the pipe covering section, which will give rise to excessive heat loss. To measure the hardness characteristic of molded insulation a penetration method of test has been devised. A diagrammatic sketch of the apparatus is given in Fig. 3.

The 1-in. tapered portion of the ¼-in. rod is calibrated in millimeters and the depth of penetration is recorded as an index of comparative hardness of samples. In performing the test, the tip of the rod is brought in contact with the surface of the test specimen before it is released, so that no impact stress is introduced.

From the foregoing, it is evident that the transverse test cannot be relied upon to give full information, and it would seem that the most dependable single test is that of impact resistance, since it most nearly duplicates the circumstances that render molded insulation unfit for permanent and satisfactory service.

Heat Test for Insulation

Preceding tests have stressed means of determining the mechanical strength and physical durability characteristics of an insulating material. Occasionally a method of testing the heat resistance of insulating materials is required.

Naturally, the only true test for the ability of a material to stand up under the temperatures to which it is subjected is the test of time under actual service conditions. However, it is not often desirable to conduct such a long-time test to determine the characteristics of the material for purposes of approval under a specification or for purchasing. A speedy heat test is wanted which, although not conclusive, will furnish a reasonable indication of the suitability of the material.

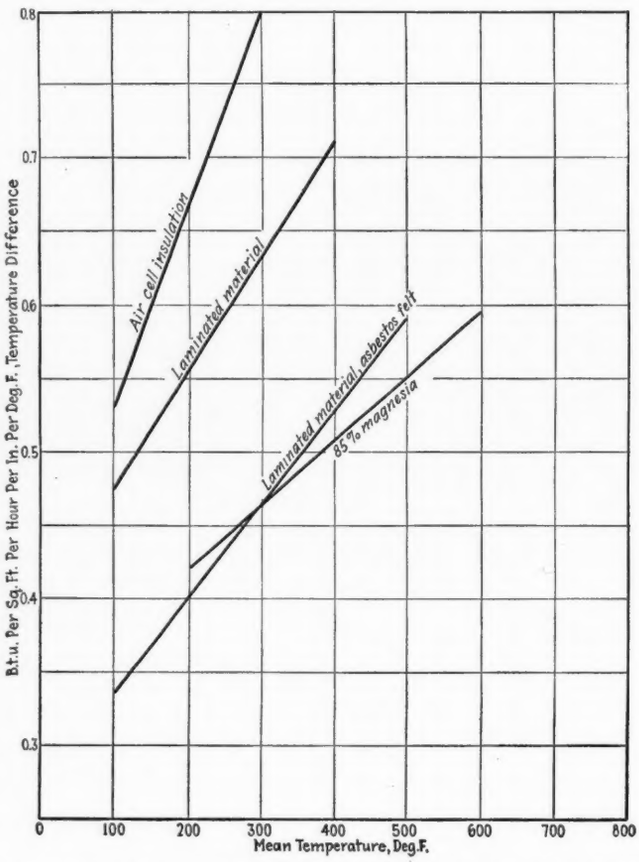


Fig. 2—Typical thermal conductivity of various types of insulation

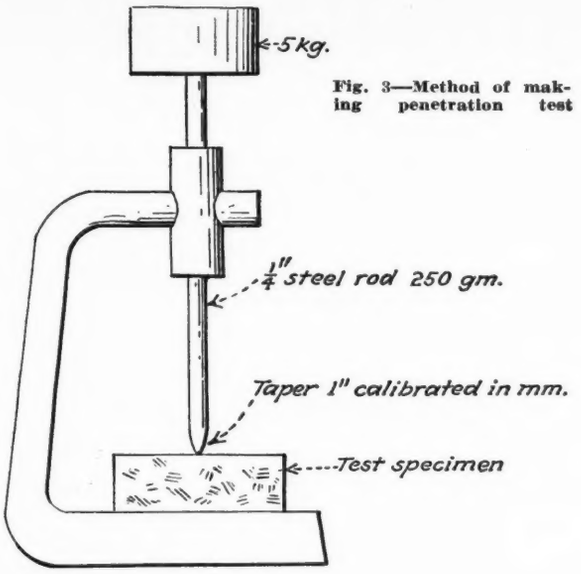


Fig. 3—Method of making penetration test

For such purposes the electric oven test is generally used. A conveniently sized piece of insulation cut from a standard factory-run block or section of insulation, usually 2x3x6 in., is placed in an electric oven for a period of from 18 to 24 hr. The temperature is increased gradually to the maximum under which the material is to function, and the sample is left to soak at this temperature for the duration of the test.

Before heating, certain data are recorded and usually consist of the color of the test sample, its weight, its dimensions and its hardness. After test the same data are noted, and, from the records, information regarding heat shrinkage, mechanical strength and disintegration is determined.

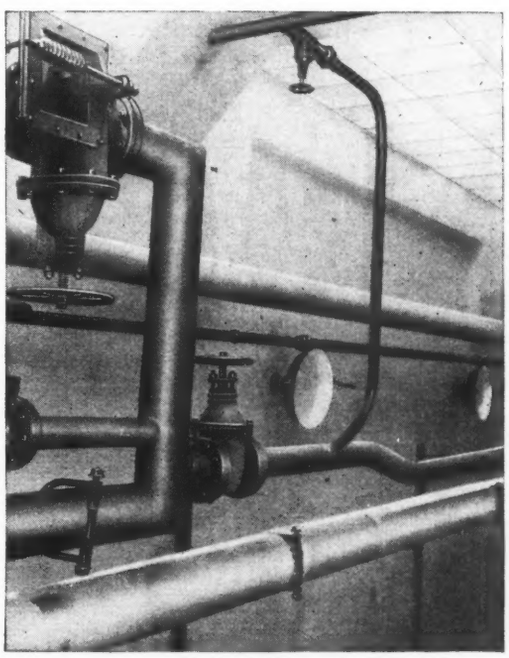
In making conclusions from an electric oven test the engineer should bear in mind that the most severe heat conditions have been imposed upon the sample. The material has been subjected throughout to the maximum temperature to be met. In actual use the insulation is exposed to maximum heat only at its inner surface, and the temperature decreases rapidly in passing through the thickness of the material. Therefore, the results obtained from an electric oven test for shrinkage, softening, etc., are not representative of the material's performance in practice. Recognition of this fact is necessary if fair consideration is to be given the materials. Of course, if comparative tests are being made and the samples of several different brands of material recommended for the same temperature range are all subjected to identical conditions of test, the electric oven test will give reliable data regarding their relative characteristics.

Insulation is bought to save heat, but it is difficult for the engineer to check the claims of manufacturers on the thermal efficiency of a product without the use of a laboratory in which samples of materials of different brands can be tested under identically the same conditions. To put two or more samples of competing brands of covering on the same pipe and feel which appears to be hotter will not indicate the insulating value of the samples. This point is evidenced in everyday experience when in the same room we feel a piece of metal with one hand and a piece of wood with the other. Although the temperature of the materials is the same, the metal piece feels cooler than the wood.

The installation of several thermometers or thermocouples per section of covering will give more reliable information regarding the relative insulating value of the samples tested. The thermocouples should be placed at the same depth under the canvas jacket (which should be identical on all samples) and held securely against the insulation. Thermometers should be placed the same distance from each test section to determine the air temperature, and the air circulation around test pieces should be uniform. This last point is the main reason why actual service tests to determine relative conductivity are so unreliable, since the rate at which heat is taken up by surrounding air affects the surface temperature of insulation to a surprising degree.

The most reliable information regarding the relative insulating value of various makes of heat insulation is available in articles on this subject read before the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers and printed in their journals. In this connection it should be pointed out that the source and reliability of test data should be thoroughly investigated by the engineer to determine their impartiality. A judgment of the merit of insulating materials based on efficiency is misleading unless all the efficiencies are based upon the same table of bare pipe losses and thermal conductivity characteristics arrived at under the same test conditions.

The next article will discuss commercial types of insulation for moderate temperatures.



Pipe layouts like this still seem a bit modernistic to the old timers, but they are becoming increasingly common in the rapid extension of welding. This photograph, obtained through the courtesy of the Linde Air Products Company, shows oxy-acetylene welded piping in a large modern industrial plant.

Experience With High-Pressure Boilers in Central Europe

A previous article, in the October 7 number, discussed European experience with the Loeffler boiler. This article relates experience with the Benson and Schmidt boilers

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SOME of the leading engineers in this country advance the opinion that the present-day common boiler design can be used for high pressures if proper attention is given to the fundamental rules of good boiler practice. In Europe, too, we find this opinion is held by some, judging from the fact that a second high-pressure installation built along lines of common boiler design has been put into operation recently. The first one, at Mannheim, for 1,500 lb. has been operating about two years. Some difficulties have developed on account of faulty circulation. The newer one is the 1,700-lb. plant completed last fall at the Ilse Bergbau A.G. in the lignite mining district to the south of Berlin. This plant is also distinguished from other high-pressure installations in that it is the first one to operate against back pressure. An interesting and elaborate study preceded the decision to place this plant on a high-pressure basis. The high points of this study are that, although the boiler plant can satisfy the plant's electrical demand when operating at 200 lb. pressure and 40 lb. back pressure, high-pressure operation above 1,500 lb. may prove profitable if the excess power can be sold at a sufficiently high figure; this in spite of the computed fact that production cost, as well as fixed charges per excess kilowatt hour, are lowest at 500 lb.

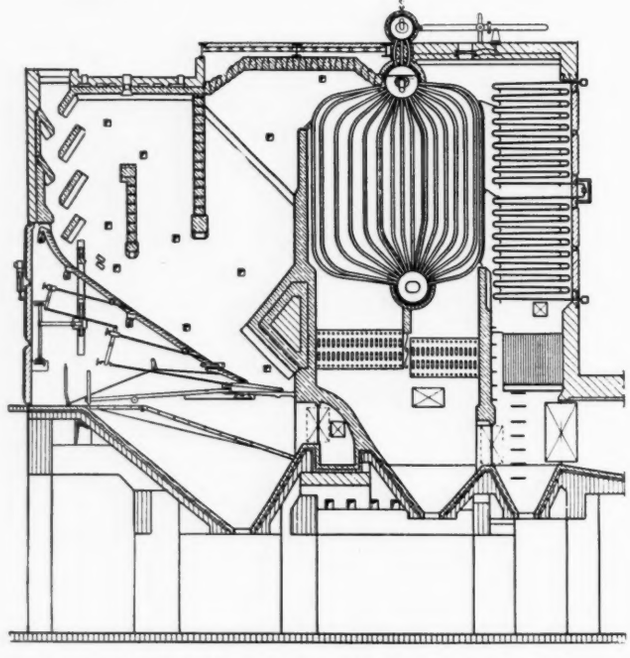

Fig. 1—First 1,700-lb. boiler installed at Ilse Grube has downcommers arranged in the center

The Ilse Grube A.G. is the largest lignite mining firm in Germany. The following figures furnish a picture of its size: 40,000 tons of lignite are mined daily, of which 24,000 tons are made into briquets, 8,000 tons are sold raw and 8,000 are used in its own power plant. The fuel is burned as mined, with its high moisture content of 58 per cent. This firm has been doing pioneering work in steam generation since 1894, when it installed the first 200-lb. plant. It was also the first to operate at 300 lb., toward the end of the war, and was again the first to use 500-lb. boilers, in 1924.

Plans for the future provide for a total of four boilers of 88,000 lb. per hour maximum capacity each. Of these, two have been in operation since last fall, but only since March have they been operating at the pressure for which they were designed. Although both boilers were ordered at the same time, they differ somewhat in design, as can be seen in Figs. 1 and 2. Of the two designs, it appears that the one in Fig. 2 presents a better solution. Notice that the downcomers are taken entirely out of the path of the flue gases and placed in the side walls, which simplifies the design and improves the circulation. Compared with the installation at Mannheim, which is also of the two-drum type, this boiler has much shorter and more simply constructed water tubes and no water-cooled furnace walls. It is therefore understandable that no circulation difficulties have been noticed. Even when operating at an evaporation rate of 16 lb. of steam per square foot, equivalent to 460 per cent rating, the water level does not show any signs of unsteadiness.

The feed water conditions are rather adverse. Condensate from the driers is used, and is heated with exhaust steam from the engines driving the briquetting machines. The condensate, returned from the driers under pressure, is freed of oil on its way to a closed surge tank. In spite of the elaborate oil-separating equipment, the condensate still contains 0.8 parts of oil per 100,000. No further conditioning is done except for the addition of one part of trisodium phosphate per 100,000. No other high-pressure plant is known to use feed water with traces of oil, and it will be interesting to see whether there is any foundation to the opinion of some operating engineers that operation with such feed water is not feasible.

There are two feed pumps driven by multi-stage turbines, of which one is a spare, and one emergency pump driven by a single-stage turbine arranged for quick starting. The pumps, built by Escher Wyss, have the stages alternating from one side of the pump to the other, with the discharge in the center, as shown in Fig. 3. The axial thrust is thus greatly compensated,

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and as the high-pressure stages are in the center the difficulties attending high-pressure packing are avoided. The stages are connected by conduits cast in the pump casing. The feed-water pressure is 60 lb. above the boiler pressure. To maintain a uniform pressure differential across the feed valve under changing load conditions, as required for proper water level regulation, and at the same time counteract the unstable characteristics of the feed pump, an overflow valve is provided in the feed line. This valve opens when the pump output drops to a point where the pump characteristic commences to descend, thus holding the pressure under all circumstances. The bypassed water is returned to a surge tank. Feed-water regulation is very satisfactory.

The emergency pump will start automatically at a predetermined low-pressure limit and carry the entire load within 30 sec. Doubt was expressed whether such a high degree of precaution was justified in view of the fact that the header drum is not exposed to flue gases and that its content could not evaporate in less than five minutes, within which time the spare pump could readily be brought into service.

A novel idea in controlling superheat, first introduced at Mannheim, was noticed. The superheater is divided into two stages. A thermostat controlled by the temperature of the steam in the turbine admission line actuates a valve that permits feed water to be sprayed into the steam before it enters the second stage. In this way the steam temperature can be kept quite uniformly at 820 deg. F. even under changing load.

With respect to water gage glasses, the best of them have not lasted longer than 400 hr. Remote indicating gages similar in principle to the McNeil gage are being installed.

One reason why the plant could not start operating with the high pressure for which it was designed was the trouble experienced with cast-steel valve bodies and fittings, which would not stay tight. They were finally replaced by forged ones.

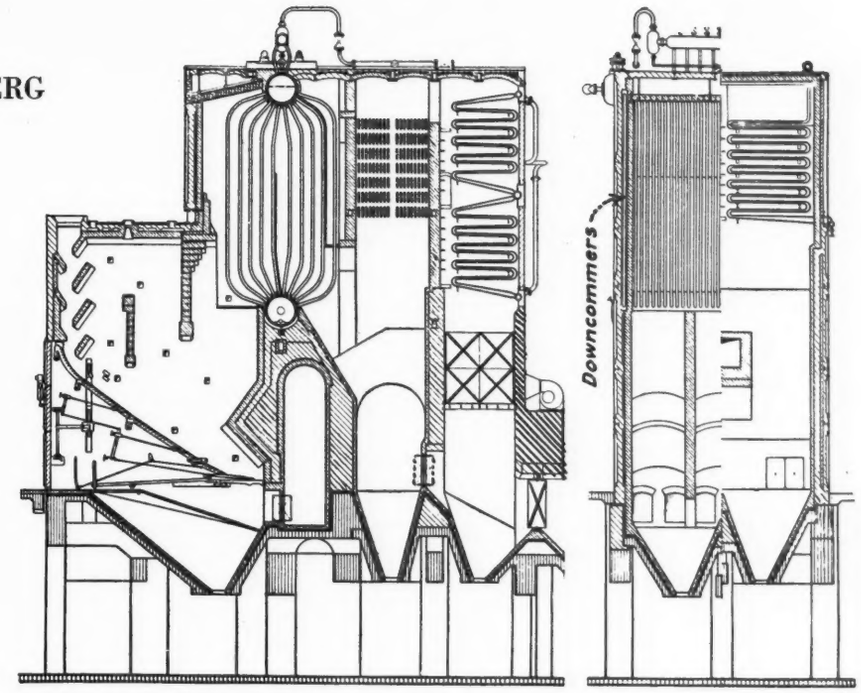


Fig. 2—In the second high-pressure boiler at Ilse Grube the downcommers were placed in the side walls

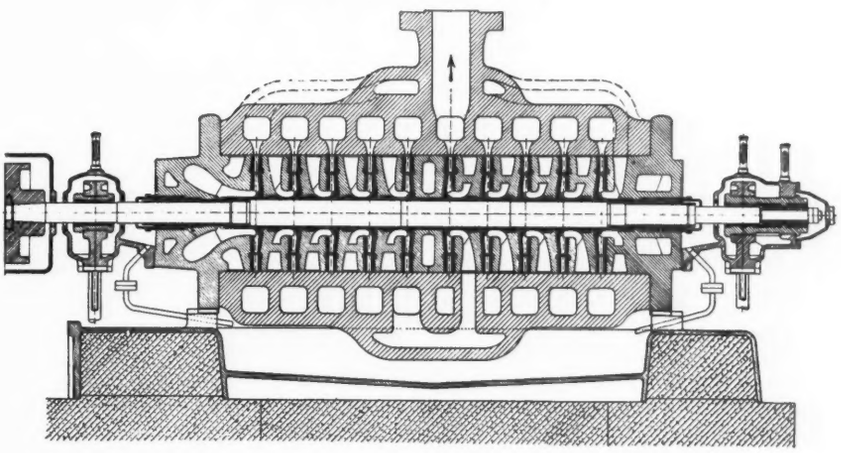


Fig. 3—Feed-water pump with center discharge and stages alternating from side to side

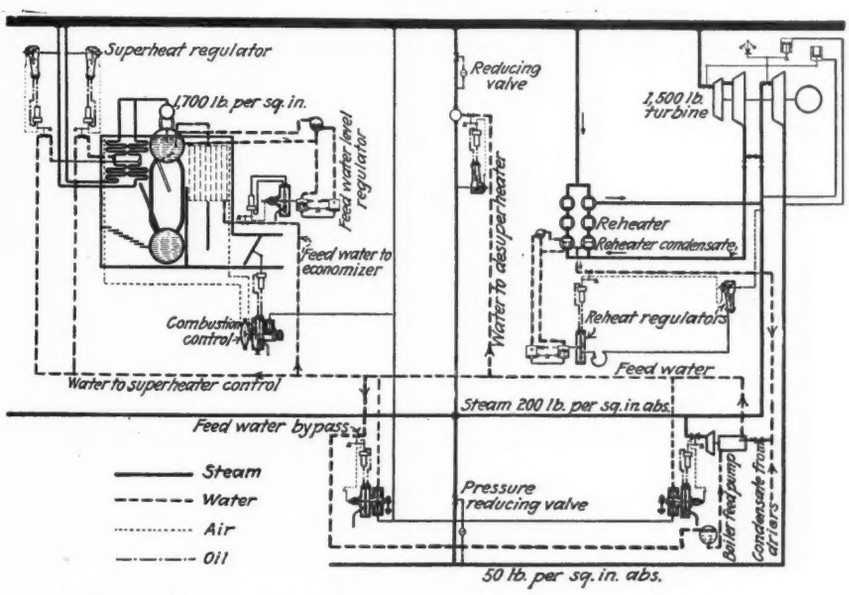


Fig. 4—Diagram showing automatic control of steam and feed-water

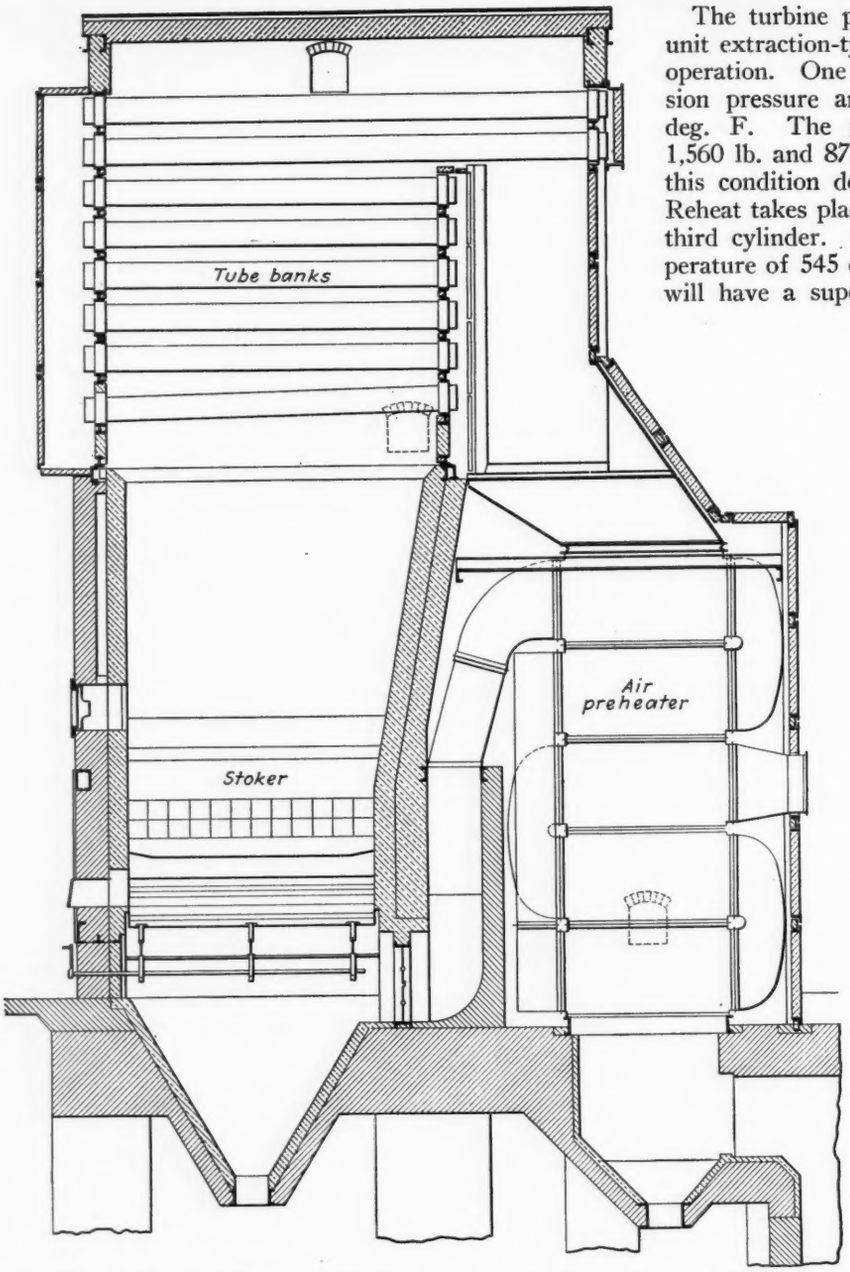


Fig. 5—Benson boiler of 16,500 lb. per hour capacity at the I. G. Farben Industrie in Bitterfeld

Bodies of molybdenum cast steel are used on the large valves. Flange joints are of the groove-and-tongue type. Gaskets are either corrugated soft steel with graphited asbestos filling or pure nickel rings with annular ridges of triangular shape. The flange bolts are made of a special alloy of a high proportional limit. Welded steam pipe joints are reinforced with flanges having only half the numbers of bolts. Joints in feed-water lines are welded and reinforced with four welded pads. Auxiliary pulverized fuel firing is provided to take care of peak loads at such times when the fuel beds, dirtied from a few days' operation, are incapable of handling a peak load. This auxiliary firing also helps to dispose of the coal dust formed in the driers. It is precipitated electrically and deposited in storage hoppers. Complete automatic control is provided, although hand control is being used for the time being for better observation.

Quite significant is the statement of the chief engineer that the 500-lb. plant back in 1924 was more troublesome than the new one.

The turbine plant consists of two 12,000-kw. three-unit extraction-type turbines designed for back-pressure operation. One of these units is a spare. The admission pressure and temperature are 1,420 lb. and 842 deg. F. The guarantee reads that a maximum of 1,560 lb. and 877 deg. F. will cause no harm providing this condition does not obtain longer than 15 minutes. Reheat takes place at 192 lb. before the steam enters the third cylinder. Steam is used for reheating to a temperature of 545 deg. F. At this reheat the final exhaust will have a superheat of 36 deg. F., which, as established by tests, gives better results in the driers. The special control as worked out to suit the particular operating conditions may be seen from the steam diagram, Fig. 4, which also shows the complete automatic control of the entire plant.

The I. G. Farben concern is known as among the largest industrial enterprises in Germany. It operates a 100,000-kw. station supplying power to the manufacturing industries in Bitterfeld and surroundings.

Use of high-pressure steam for future expansion offers great possibilities, because of large process steam requirements and a ready market for electric power among its own diverse industries. At present steam is generated at 300 lb. pressure. In view of differing opinions as to what type of high-pressure boiler should be adopted, it was decided to install two boilers of different makes side by side and to test them over a long period of time under similar operating conditions. A Benson and a Schmidt boiler were chosen for this purpose.

The Benson boiler, illustrated in Fig. 5, was placed in service in the spring of 1929 and had a total of 2,100 operating hours to its credit at the time of the visit. It has a normal capacity of 16,500 lb. per hour and is fired with lignite. The original boiler was changed by replacing the multiple water-carrying $\frac{3}{4}$-in. I.D. tubes with a single tube $1\frac{3}{8}$ in. I.D. x $\frac{3}{8}$ in. thick. It was found that with the multiple arrangement it was impossible to obtain uniform distribution of flow; hence the heat input to the tubes would vary, resulting in overheating and tube failure. It should be mentioned, however, that since this boiler has been put up the makers have made a number of improvements incorporated in more recent installations, which tend to correct this fault. In these latter boilers the tubes are helically wound around the combustion chamber, thus permitting of a more uniform distribution of both water and heat. It should also be said that many of the parts making up this installation belong to the Benson[1] boiler installed at the Siemens' works in 1924. The large triplex feed pump is, therefore, out of proportion to the size of the boiler.

Experience has shown that only pure condensate will do for feed water. It is fed to the boiler at about 140 deg. F. As no high-pressure turbines are installed,

[1]*Power*, May 31, 1927.

the steam has to be delivered at the plant's normal pressure of 300 lb. To do this without the formation of moisture during the throttling process the steam must leave the Benson boiler at a temperature of 785 deg. F. After throttling, the steam has a temperature of only 400 deg. F. It is therefore raised again to the superheat of the normal-pressure steam. Due to the high specific heat of the steam at the higher pressure, danger of greatly exceeding the superheat temperature of the steam ahead of the throttle with a lagging fire after a drop in load is greatly reduced. Conditions would be still more favorable if stage throttling were used, because it would permit of a lower superheat temperature, say 740 deg. F. to 750 deg. F., at which the specific heats are considerably higher. The boiler would then be less sensitive, a desirable characteristic in view of the V-type stoker that does not permit of the close control of the fire preferable for Benson boilers. Because of the unfavorable operating conditions, it is not surprising that the attendant has to be constantly on the watch. On the other hand, the failure of a tube does not cause much concern—in fact a tube had burst only a few days previously to the visit and had given no outward sign other than a hissing sound. Of course, the fire doors have safety latches to prevent the fire from being thrown out. The positive pressure created by the sudden escape of the steam, however, amounts to only a few inches of water. The tube is quickly repaired by ox-welding, whereupon the boiler is again put into service.

The tube mentioned above was installed after careful examination. During the hydrostatic test it was accidentally discovered that small beads of water had collected on a portion of the surface. The section was cut out and sent to the laboratory for a higher hydrostatic pressure test. At 3,800 lb. pressure the water came forth in a stream from what was found to be a crease or fold invisible to the naked eye. The crease was traced to a flaw caused by the rolling operation in manufacturing tubes by the Mannesmann process. Careful attention is now given to the elimination of such flaws, but the incident serves to show the great care required in selecting material for high-pressure boilers.

Among the other tube failure samples, which make a most interesting collection, there was one taken from the superheater with signs of an unusual corrosive action the nature of which has not yet been explained. It is possible that the decomposition of steam, lately proved to take place in superheaters at temperatures above 930 deg. F., was at the bottom of the failure.

The Schmidt boiler in Fig. 6 is made up of two primary units each fired independently by a V-type stoker on which lignite fuel is burned. It has a normal capacity of 33,000 lb. per hour and a maximum output of 40,000 lb. per hour. The final pressure is 1,420 lb., which calls for a pressure of about 2,100 lb. in the primary system. The steam is superheated to a temperature of 750 deg. F., after which it is throttled down to the plant's normal pressure of 300 lb. Raw water was tried for feed, but with poor results, as the vaporizing coils became badly incrusted. Consequently, condensation is used for feed water, and as it has a hardness of about 0.5 gr. per gallon soda ash is added to it. Deposits still form on the coils, but are of a harmless nature and are easily removed during periodic cleanings.

The feed water is heated by steam to 390 deg. F., after it has been raised to a pressure of 350 lb. by the first centrifugal pump unit. It then passes to the second pump unit, which feeds it directly to the boiler evaporator drum.

Make-up water for the primary system is pure deaërated condensate. At the beginning no deaëration was employed and more make-up was used than at present, on account of leaky joints. As a result of the relatively large amount of air, failure by corrosion occurred in the lower row of tubes.

The evaporator coils have been replaced by others

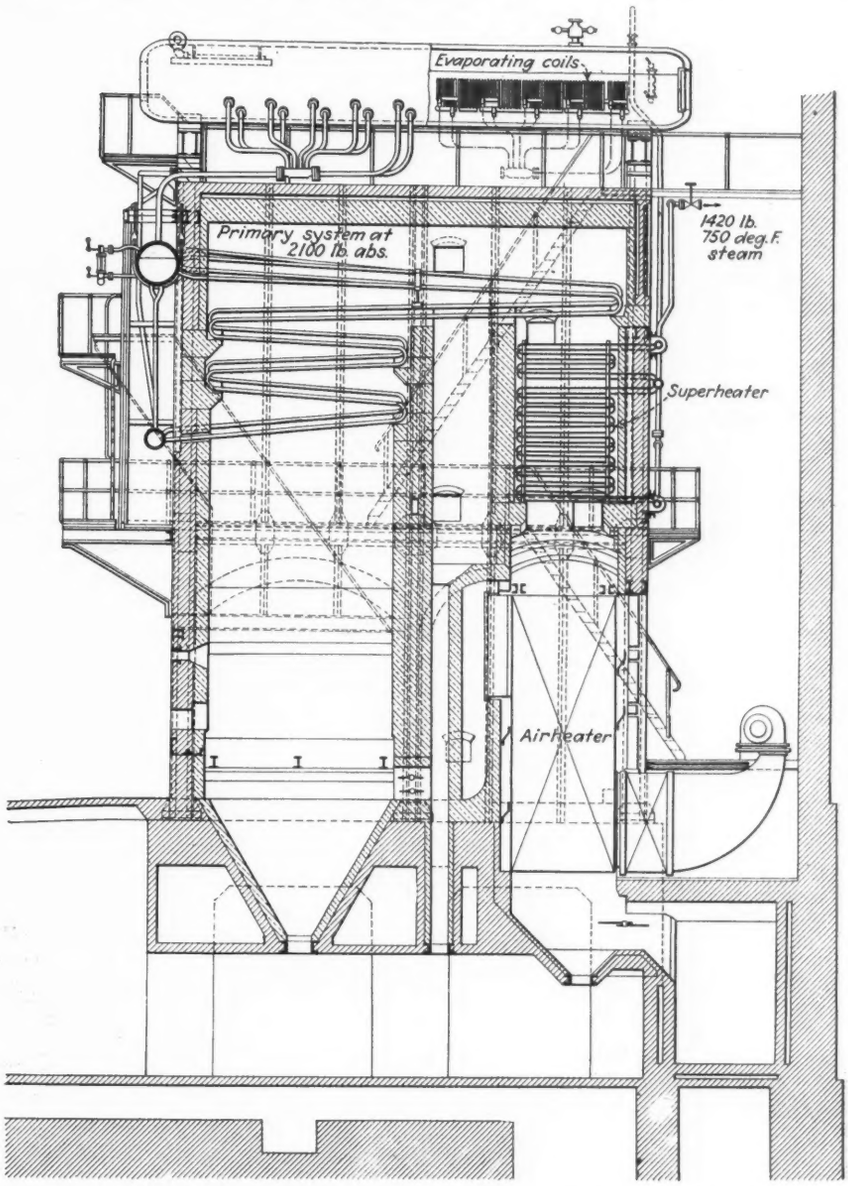


Fig. 6—Lignite-fired Schmidt boiler of 33,000 lb. per hour capacity at the I. G. Farben Industrie

that have the tubes bent in a spiral, thus eliminating the sharp bends that cracked at the inner side due to expansion strain. In more recent designs the evaporator coils run lengthwise, which is a great improvement. Not only are the number of connections through the drum shell reduced, but it also permits fewer and larger bends and allows the counter flow which the spirally wound coils made impossible.

The boiler tubes of the primary system are factory butt-welded to the required length. They were rolled into the drums after the ends had been thinned out by counter-boring. When first installed, the circulation of the water was unsatisfactory. Investigation revealed that fins formed inside the tubes during building had not been properly removed. Before re-installing the tubes a ball was driven through them to insure that the cleaning had been thorough.

The following pressures and temperatures illustrate briefly how the boiler operates:

	Primary System		Secondary System	
	Pressure Lb. per Sq.In.	Corresponding Temperature Deg. F.	Pressure Lb. per Sq.In.	Corresponding Temperature Deg. F.
At end of banking period.....	480	463	480	463
After 10 minutes operation...	1,650	608	1,200	567
Steam turned on.....	1,270	574	900	532
Pressure rising slowly with steam turned on.....	1,980	634	1,420	589

Regulation is by hand, and attendance is much the same as with a common type of boiler. So far as the man in charge is concerned, the primary system does not exist except for an occasional check of the water level in the boiler drum.

The superheater, of course, presents the same problem as in a conventional type of boiler, that is, the danger of overheating in the event of a drop in load if too high a superheat is carried. There is no reason, however, why an arrangement such as that used at Ilse Grube could not be employed and so permit higher superheats. The attendance is simplified by a large dial thermometer on which the saturated and superheated steam temperatures may be read. The relative positions of the thermometer pointers tell the operator at a glance what the boiler is doing.

A new type of water level indicator is being tried out on the primary system. It consists of a pot in communication with both the steam and water space by means of long tubes of small diameter. The weight of the water in the pot will change with the water level in the drum and thus cause more or less deflection, which is registered on a dial by a scale. The possibility of the small tube's becoming clogged may prove a serious handicap to the adoption of this gage. For the secondary steam drum a remote water level indicator of the type mentioned in connection with the Ilse Grube installation is being tested.

So far as the piping of both boilers is concerned, the tongue-and-groove flange joints with soft steel gaskets, as well as those with conically countersunk ends and packing rings of elliptical cross-section, have proved reliable, and no further trouble is expected from this source.

An opinion as to which of the boilers has proved the more satisfactory could not be obtained. On the other hand, it is the writer's belief that such an opinion could carry no weight, because the characteristics and fields of application of the boilers are so different that a comparison on a test, even if based on similar operating conditions, cannot be drawn.

Working Stress Proposed for Pipe Bends

IN A PAPER presented at Stockholm at the third International Congress for Applied Mechanics, William Hovgaard, Cambridge, Mass., proposed a definite working stress, permissible in pipe bends. These conclusions were based on four years' study of the behavior and strength of curved pipes subject to the action of terminal forces such as arise in expansion bends inserted in steam pipe lines, and on tests made during the years 1926, 1928 and 1929.

A good correspondence was found in the general character of the curves for calculated and observed stresses at moderate loads, but when approaching the elastic limit of the bends the observed stresses generally had higher maximum values than the calculated. The discrepancy is ascribed chiefly to local flow of material in the most highly strained parts.

In all tests it was found that so long as the maximum value of the calculated longitudinal stress, as found from equations given in the paper, did not exceed 20,000 lb. per square inch, there was no appreciable permanent set in the pipe bend. Having regard to the field covered by the tests, this limit may be expected to hold for all moderate- and high-pressure pipes, whether lap-welded or seamless, provided the pipe is not bent to a radius less than four or five diameters and that the material from which the pipe is made is a ductile, low-carbon steel or iron of good quality with a yield point of not less than about 25,000 lb. per square inch.

Although, apparently, when a longitudinal stress of 20,000 lb. per square inch is reached the pipe as a whole is within the elastic limit, yet it is likely that overstrains will exist locally in the most strained parts of the pipe and that repeated applications of the same load will in time produce a permanent set. It is recommended, therefore, to design for a substantially lower stress, say 16,000 lb. per square inch, but in calculating this stress the compression due to end forces, and in certain cases the stress due to internal steam pressure, should be included.

***ONE of our good friends has inquired as to whether there are in existence any engines built by* MATHIAS BALDWIN, *around 1837. We do not know of any, but perhaps some reader may know of such an engine that is to be found in some obscure place. If so, we should like to know about it*—EDITOR.**

New Mixed-Pressure Turbine Application

By NORRIS D. GOVE
Engineer,
Westinghouse Electric & Manufacturing Company

Due to increased power requirements, the Cananea Consolidated Copper Company was faced with the necessity of making a considerable extension to its Sonora, Mexico, steam plant. It installed a mixed-pressure turbine that uses surplus waste-heat steam and can carry full load on either high- or low-pressure

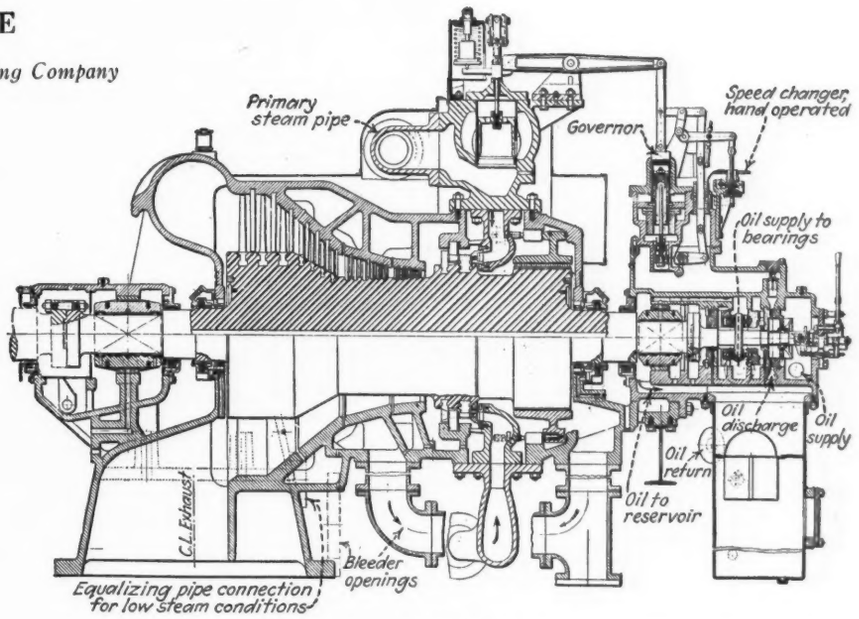


Fig. 1—Longitudinal section through standard 6,000-kw. turbine redesigned for mixed-pressure service

THE Cananea Consolidated Copper Company had in operation a 150-lb. waste-heat boiler plant supplying steam to two old turbines, to numerous reciprocating engines and for other plant uses. Under the new production schedule, an excess of waste-heat steam was expected averaging 20,000 lb. per hour and reaching peaks of 50,000 lb. per hour. There was also a battery of 200-lb. hand-fired boilers suitable for stand-by service. The excess waste-heat steam was not enough to carry the expected immediate increase in load, totaling 4,200 kw.; consequently, additional steam-producing capacity had to be planned, together with increased turbine-generator capacity.

It was decided to install a 400-lb. boiler, with pulverized-coal fuel, and to utilize the steam from this boiler and from the 150-lb. boilers in a single turbine of the mixed-pressure type. A turbine rating of 6,000 kw. was established to meet future increases in power demands, but the manufacturer was requested to consider performance at 4,200 kw. as most important.

In the preliminary design work on this machine the manufacturer's engineers considered a turbine of the simple mixed-pressure type in which the 150-lb. steam would be admitted into the middle section of blading. However, the available supply of this steam varied to such an extent that excessive throttling losses were encountered at normal flow, which led to an investigation of the practicability of nozzle control.

As the basis of the design, there was available the standard 6,000-kw. straight-condensing frame, shown in Fig. 1, in which the steam is expanded first through a two-row impulse wheel entering this blading through four groups of nozzles under governor control. The balance of the expansion is through reaction blading, which is so proportioned as to obtain an impulse chamber pressure (second-stage inlet pressure) varying from 75 lb. to 125 lb. abs. at full load. The four nozzle groups are arranged opposite the greater part of the circumference of the impulse wheel, with the primary nozzles located in the cylinder base and connected to the primary valve in the steam chest by a pipe. The secondary, tertiary and quaternary nozzle blocks are located in the cylinder cover and take steam directly from their respective valves.

Fig. 3 is a section of the steam chest showing a steel plate welded in so as to separate the primary and secondary valves from the other two.

The end view, Fig. 2, of the assembled steam chest and nozzles shows how the two steam supplies were piped to the steam chest, each being under the control of two governor valves. The 150-lb. steam passes through the primary and secondary valves, while the 400-lb. steam is controlled by the tertiary and quaternary. With this arrangement low-pressure steam is first admitted up to the full amount available, assuming that the load requirements exceed the 150-lb. steam supply; then the high-pressure valves open in sequence, passing enough steam to carry the balance of the load.

It is expected that under normal operating conditions

high-pressure steam will be required at all times. Consequently, the primary and secondary governor valves will be open most of the time. It can readily be seen that with small amounts of low-pressure steam available and with the nozzles laid out for large steam flows, the pressure at the 150-lb. boilers would be greatly reduced, which would interfere with the operation of other equipment. To prevent this trouble a constant-pressure valve of standard make is installed in the 150-lb. line and set to close at boiler pressures below 150 lb., so that the turbine receives low-pressure steam only after the demands of the rest of the plant have been satisfied. The constant-pressure valve is easily adjustable over a range of from 125 lb. to 200 lb. and will probably ordinarily be set at about 140 lb. to allow considerable fluctuation in boiler pressure.

The turbine manufacturer had to allow for a maximum low-pressure flow of 50,000 lb. per hour. It was expected, however, that for some time the flow would be less than half this amount. To reduce throttling losses with the smaller flow and with both low-pressure governor valves wide open, a globe valve was placed in the pipe leading to the primary nozzles in the base of the turbine. With this valve closed, the low-pressure nozzle capacity is reduced about 50 per cent, low-pressure steam passing through the secondary valve only. It would have been possible to have substituted an automatic valve for the globe valve, but the added complication seemed scarcely worth while.

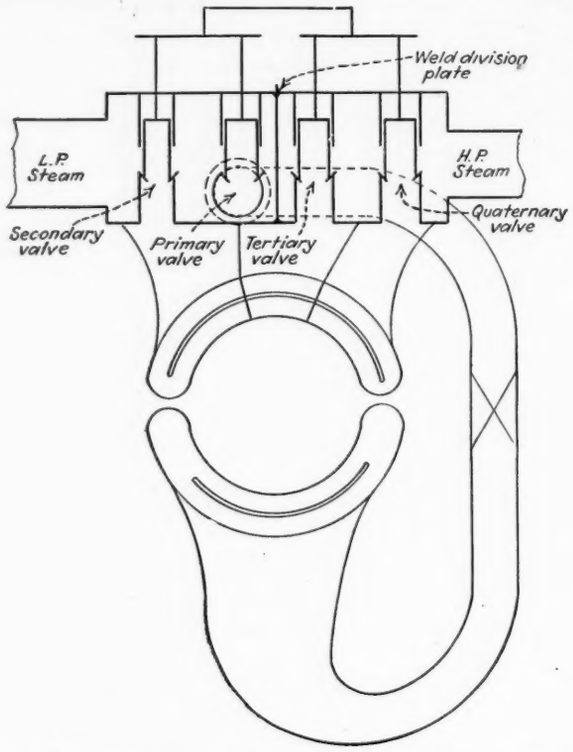


Fig. 2—Diagrammatic end view of turbine, showing nozzle arrangement

The high-pressure nozzles were laid out to pass enough steam so that with normal low-pressure steam flow full rating could be carried. As a consequence, the turbine will not carry full load on either 400- or 150-lb. steam alone. However, with either set of boilers down, the 200-lb. hand-fired boilers can be used instead, replacing the battery that is out of service. Further flexibility is insured by the fact that at times when the available

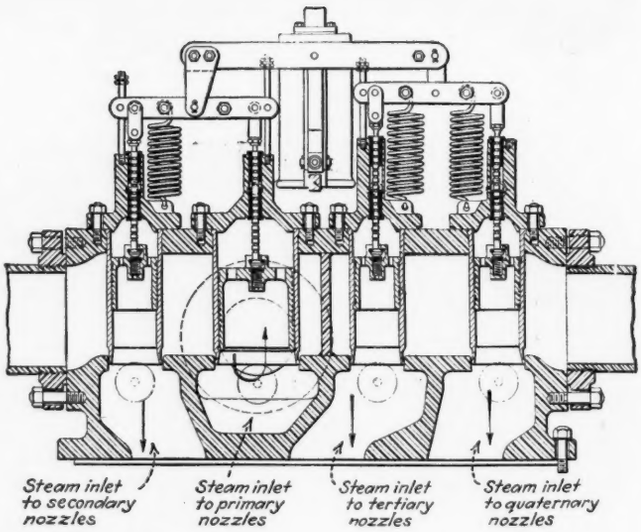

Steam inlet to secondary nozzles
Steam inlet to primary nozzles
Steam inlet to tertiary nozzles
Steam inlet to quaternary nozzles

Fig. 3—Section through steam chest, showing division plate installed, to separate high- and low-pressure steam

supply of 150-lb. steam is very small 200-lb. steam can be throttled into the 150-lb. line, where it will come under control of the constant-pressure valve. The turbine will not be endangered by the use of 200-lb. steam, as each throttle and the steam chest are good for 400 lb. pressure. The constant-pressure valve is 200 lb. standard, so that when the 150-lb. boilers are shut down the 200-lb. steam can be used without throttling.

In spite of all this seeming complication, the turbine can easily be converted to normal condensing operation at any steam pressure between 150 and 400 lb. New nozzles would be required, the partition in the steam chest would have to be burned out and the extra throttle valve discarded.

The standard turbine had four bleeder openings from which steam could be drawn for feed heating. For this application all four openings were used. From the three lower openings steam was taken to heat the turbine condensate and also a large amount of make-up water. The amounts of steam extracted were, as a consequence, so large that a condenser of reduced size could be used. A small amount of steam is taken from the high-pressure bleed point for use in dry kilns. Fig. 4 is a diagrammatic sketch of the feed-heating system.

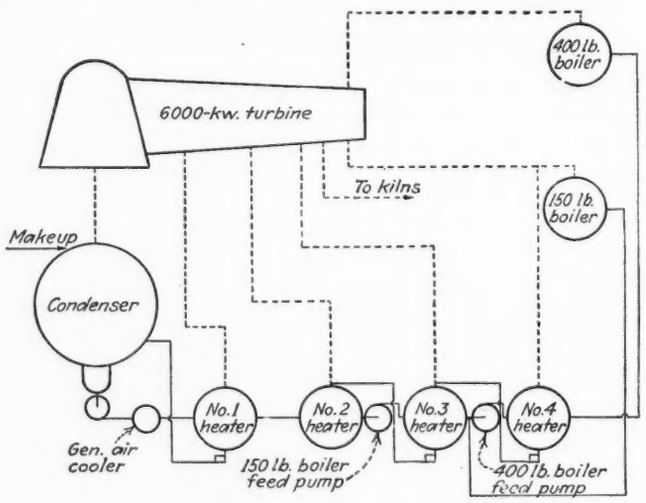
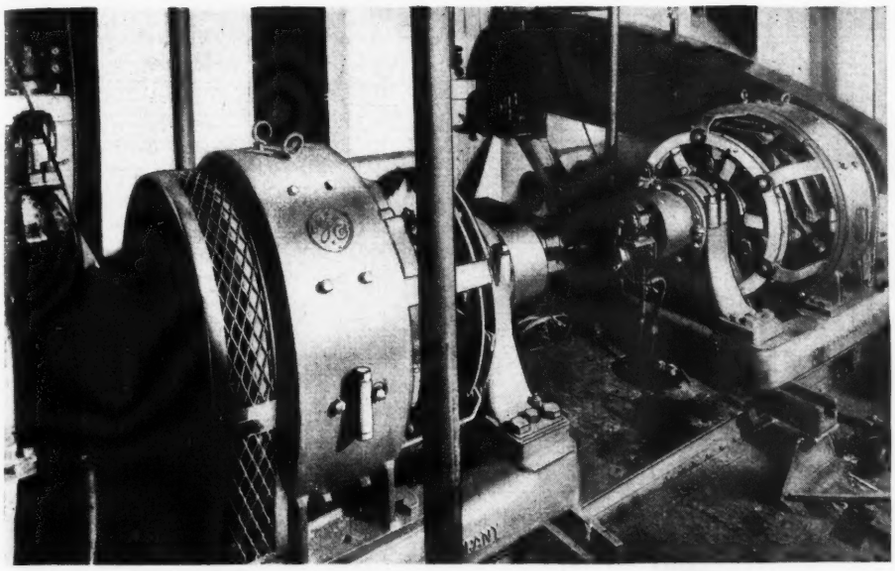
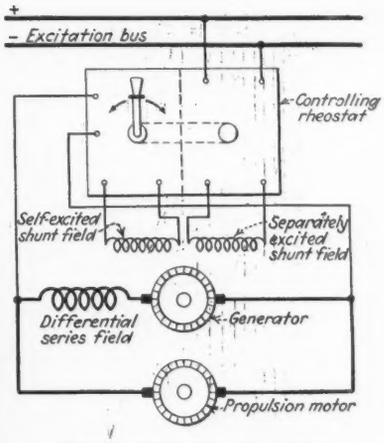


Fig. 4—Plant heat-balance diagram





Above—Diagram of generator and motor connections

Left — Two 115-hp. 360- to 600-r.p.m. shunt-wound propulsion motors

Full Load on Diesel Engines Maintained Automatically

By H. P. BISH
Federal & Marine Department
General Electric Company

A UNIQUE method has been evolved for automatically controlling paddlewheel speeds on Diesel-electric river towboats. The electric propulsion machinery is so designed that the motors will always run, except during maneuvering, at such a speed as to take just full load power from the diesel engine which drives the main generator. Prior to the development of the method the variation in propeller speed was accomplished through the adjustment of a motor field rheostat, and required frequent attention by the operator; otherwise, either the engine would be overloaded or the boat would be running at a speed below that at which it should operate.

With the new method speed changes under normal running conditions are entirely automatic. The operator merely sets his control at either "full ahead" or "full astern" and the motors operate at such a speed as to load the engines to their full horsepower capacity. Provision is made so that the operator can select lower speeds if he wishes.

The automatic action is accomplished by a specially designed generator. The propelling motor or motors are supplied with constant-voltage excitation at all times. Variation in speed is obtained by varying the armature voltage. Except during maneuvering, this is accomplished by the inherent characteristics of the generator, which has a self-excited shunt field, a separately excited shunt field and a differentially connected series field, as in the diagram. The characteristics of the main generator are such that the voltage increases as the current decreases, and vice versa, so that the horsepower output is practically constant over the operating speed range of the propulsion motor or motors. At full load the engine is operated on what might be termed full throttle, that is, the governor does not come into operation until the speed is above the normal full-load operating speed of the engine. Under normal running conditions the generator requires just full load from the engine at all times. As the load is thrown on and off during maneuvering the engine governor comes into operation, holding the light-load speed at a predetermined value.

The controlling rheostat in the diagram consists of two dial rheostats interconnected in such a way that movement of the operating handle the first few degrees in either direction determines the direction of excitation of the separately excited shunt field. Continuous movement of the handle in either direction successively cuts out the steps of resistance in the separately excited and the self-excited shunt fields and gives increased maneuvering speeds up to full load of the engines.

Safe Clothing

By MARTIN PHILLIPS
Electrical Supt., International Paper Co.
Niagara Falls, N. Y.

SOMETIMES we do not stop to consider what an important part our clothing plays in causing and preventing accidents.

The wearing of proper clothing at work is essential. It is to workmen what the safety guards are to moving machinery.

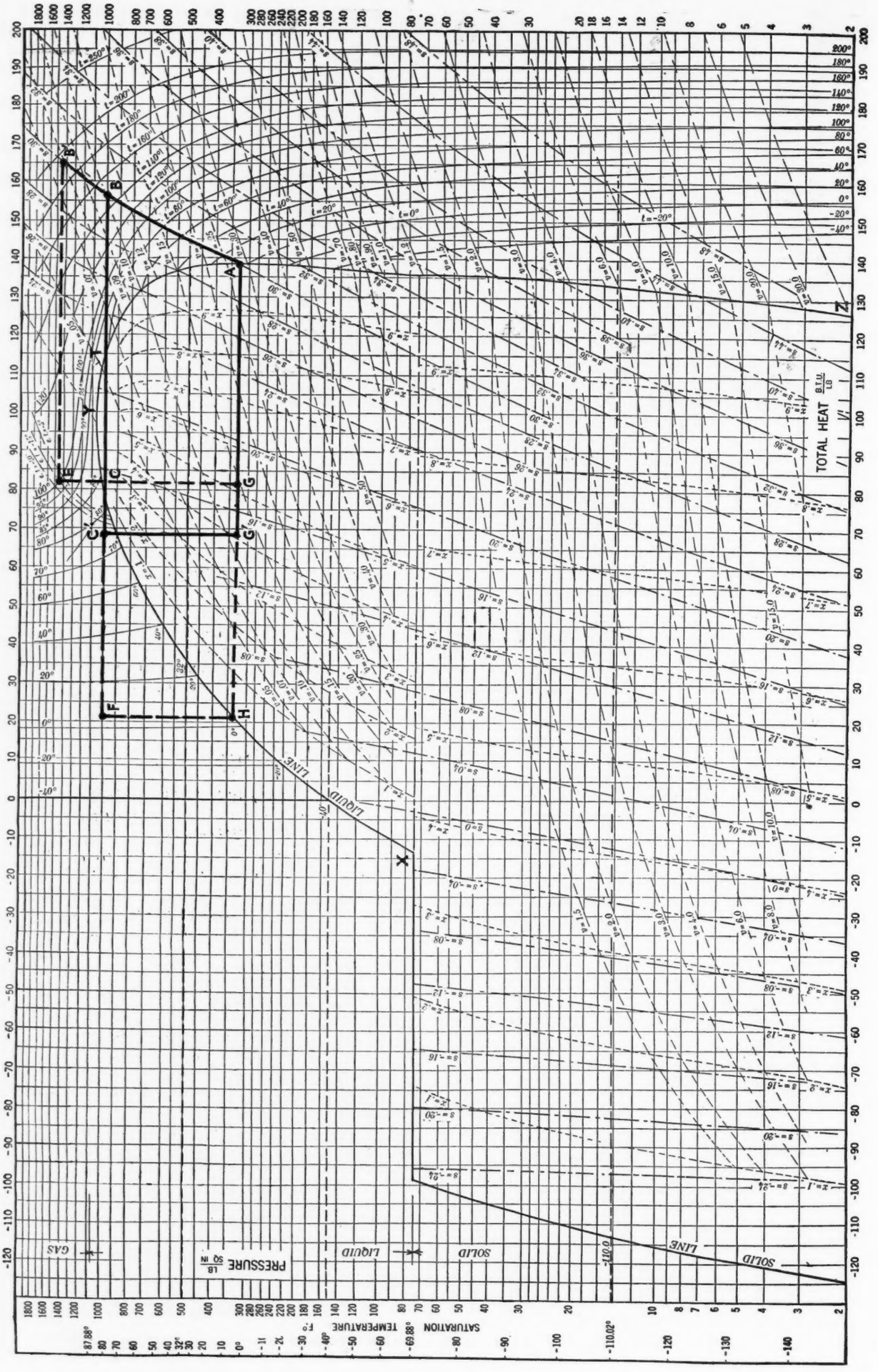
Many serious accidents have occurred to workmen from wearing loose or ragged clothing around moving machinery.

When an overall suit is worn with jumper, it should be buttoned up tightly when around moving machinery, or, better yet, kept tucked into the overalls. Trousers or overall suits with a ripped leg or sleeve should never be worn around moving machinery.

Loose or unbuttoned sleeves should be avoided. Sometimes it may be to an advantage to have them cut off at the elbow or shoulder. The sleeves should fit closely to the arms at all times. At other times, when working around hot pipes and the like, the arms should be covered to prevent serious burns.

Gloves present another source of danger. It is an extremely hazardous practice to wear them around moving machinery. Under no circumstances should they be worn when using a drill press or electric drill. Many workmen have been seriously injured from this practice.

TOTAL HEAT DIAGRAM FOR CO_2 PREPARED BY THE A.S.R.E.



MERITS OF CARBON DIOXIDE

As a Refrigerant

By F. P. MACNEILL

THE DEVELOPMENT of air conditioning, especially in the theater, has brought with it a more extended use of refrigeration. The presence of a refrigerating plant in places of public assembly requires that the refrigerating fluid be harmless in case of leakage, which has stimulated an interest in CO_2.

It has been an axiom in refrigeration practice that one of the most important qualities a good refrigerant must possess is a large ratio of the latent heat of evaporation to the heat of the liquid. This is equivalent to saying that the heat carried by the liquid from the condenser into the evaporating system must be small in comparison with the latent heat absorbed in the evaporator. To show how this influences the choice of refrigerants, compare CO_2 and ammonia working under the same temperature conditions as regards temperature of condensing water and temperature of the refrigerating coils. Let the temperature of the condensing water be 70 deg. F. and the temperature in the coils 5 deg. F.

A fully charged CO_2 plant working under these conditions will have a condenser pressure of 1,000 lb. abs. and an evaporator pressure of 334 lb., while ammonia will have a pressure of 140 and 35 lb. for the same conditions. Now each pound of CO_2 liquid leaving the condenser at slightly over 70 deg. F. carries with it into the coils, or evaporator, 68 B.t.u., figured from —40 deg. F. The heat necessary, figured from the same point, to start evaporation at 5 deg. F. is 22 B.t.u., that is, the heat in the liquid CO_2 at 5 deg. F. is 22 B.t.u. Therefore, there has been 46 B.t.u. too much carried from the condenser.

The latent heat of each pound of CO_2 liquid at 5 deg. is 115 B.t.u.; so the extra heat carried in by the 75 deg. liquid will cause an evaporation of $\frac{46}{115}$, or 42 per cent of the liquid. This is almost half the refrigerating effect of each pound of CO_2. This so-called primary evaporation does no work of cooling the substance to be refrigerated, but merely cools the remaining part of the pound of liquid to the temperature prevailing in the evaporator, before the remaining part evaporates to do useful work, entailing a considerable loss out of each pound of liquid. The heat carried in by the liquid is large in comparison to the latent heat. It also shows that only half as many pounds of liquid CO_2 would need to be circulated to produce the same refrigeration if the liquid were cooled to 5 deg. before entering the evaporator. This also means that the compressor has to handle almost twice as many cubic feet of vapor to perform the same refrigeration duty it is possible to do with the entering liquid at the temperature of the evaporator.

On the total heat chart shown on the opposite page X to Y is the liquid boundary curve; Y is the critical point. From Y to Z is the saturated-vapor boundary curve. On the left side of the liquid curve, up to the critical point, the liquid is in the oversaturated state, that is, the molecules are closer together than they are when evaporation starts at the liquid curve. Horizontal distances from the liquid curve to the vapor curve represent the process of evaporation, and the per cent lines show how much vapor is formed up to the various points until the saturated vapor curve is reached, when the pound of CO_2 liquid is completely changed into a pound of saturated CO_2 vapor. Beyond this vapor curve, the superheat region is entered, and the process of compression generally takes place within this region, unless the compressor is being run pretty wet, with a heavy freeze-back. In this event, the start of the process falls inside the vapor curve, and an estimation must be made of the per cent of liquid coming back with the vapor to locate the point at which compression starts.

The lines of constant entropy S are the paths along which adiabatic compression takes place in the superheat region. The line A to B depicts the compression of a pound of saturated vapor from 334 lb. abs. evaporator pressure to a condenser absolute pressure of 1,000 lb., the temperature of the discharge gas being 145 deg. F. Now the temperature in the bottom of the condenser due to the cooling water is about 82 deg.; so first the superheat due to compression must be removed to bring the vapor to the point of saturation before condensation can start. This brings the line back to the vapor curve at T, from which condensation proceeds until the pound of vapor is completely changed into a pound of saturated liquid at point C. Further cooling at the condenser pressure would bring it to C, where the liquid is under-cooled 7 deg. From C it passes through the expansion, or regulator, valve into the evaporator coils. The action of passing through the valve is shown by the line C to G. The position of the point on the 334-lb. evaporating line shows that the liquid carries enough heat within itself into the evaporator to cause an evaporation of 42 per cent of the pound, the other 58 per cent does useful refrigeration from point G to A, when compression starts again.

It can be seen by the broken lines that if the temperature of the cooling water had been higher, so as to give a condensing temperature of 100 deg. instead of 80 deg., the pressure in the condenser would have risen to 1,300 lb. and the temperature of the gas at discharge from the compressor to 193 deg. Carbon-dioxide gas cannot be liquefied at this temperature, which is shown by point E, being above the critical temperature of 87.78 F. and outside the liquid curve. The Joule-Thomsen effect occurs as the gas passes through the valve, and there is 52 per cent vapor and 48 per cent liquid at point G.

The point to be emphasized is that if, when working with 80 deg. condenser temperature, the condenser pressure had been raised to 1,100 lb. by charging in more CO_2, 4 B.t.u. would have been gained in the evaporator and would have expended 2 B.t.u. extra in compressing to this higher pressure. Examination of the chart will show that, in the neighborhood of the critical point, by increasing the pressure on the same temperature liquid,

its heat content is reduced, so that the refrigerating work in the evaporator is increased by that amount.

In marine work a fully charged CO_2 plant leaving the dock in temperate climate is supposed to have its condenser pressure at that point where its corresponding temperature is 15 deg. above the temperature of the sea water. This is the rule of thumb laid down on many British ships for the proper operation of their CO_2 plants. This stipulation is for sea water under 70 deg. F.; if it is over 70 deg. the condenser pressure must be increased to a point where the temperature is 20 deg. above the temperature of the sea. As the ship proceeds into warmer water it will be found the plant is becoming gradually undercharged, for the condenser pressure is falling off from what it should be so many degrees above the temperature of the sea. The refrigeration capacity falls off in step with the condenser pressure. The only thing is to put more CO_2 into the system to bring the condenser pressure up the requisite amount, whereupon the refrigerating capacity picks up but does not equal what could be done in cold water. When the ship proceeds into cooler water the plant becomes overcharged, and while it does take a little extra power to operate, the added amount of refrigeration done compensates for the increase.

In the case of ammonia, each pound of liquid leaving the condenser at about 75 deg. carries with it into the evaporator 125 B.t.u. figured from —40 deg. F. The heat that must be added from —40 deg. to start evaporation at 5 deg. is 48 B.t.u., so there is 126 — 48 = 78 B.t.u. too much heat in the ammonia liquid. The latent heat of ammonia at 5 deg. is 565 B.t.u., therefore there will be a primary evaporation of $\frac{78}{565}$, or 14 per cent. This is much less than the 42 per cent occurring with CO_2 and shows ammonia to be more efficient in this respect.

The reason why CO_2 has such a small amount of latent heat when operating at the ordinary temperature levels is that the critical point of the substance is low compared to ammonia, CO_2 being 87.98 deg. F., while ammonia has its critical point at 271.4 deg. F. When the critical temperature is reached, no amount of pressure, however great, can make the substance stay in liquid form, and the latent heat has dwindled to zero. The volume and density of the liquid and of the vapor are identically the same. But CO_2 liquid has considerable latent heat at the triple point, —69 deg. F., making this substance better suited for low temperature work.

The power necessary to compress and deliver to the condenser the pound of CO_2 vapor, under the cited conditions, is 19 B.t.u., while for ammonia it is 93 B.t.u. This may appear startling at first glance, but it will be noted that the refrigeration done is by no means the same in each case and that the pressure volume relations are widely different. The volume of one pound of CO_2 vapor at 5 deg. is 0.257 cu.ft., while that of ammonia is 8.15 cu.ft. That difference is what requires the extra power.

In the process of evaporation, a certain portion of the heat supplied is spent in doing external work, that is, in making room for the increase in volume from liquid to gas, and disappears as heat but resides in the gas as potential energy. This is returned as heat when the process is reversed and is part of the heat of compression. Also, when heat is added to gas at constant pressure part of the heat is spent in doing external work in increasing the volume, while the remainder, the greater part, is spent in raising the temperature. When the volume is kept constant and heat is added no external work is done, and the whole of the added heat goes to raise the temperature, and, consequently, the pressure. How this operates to give CO_2 a low heat of compression can be seen when it is considered that CO_2 is working close to its critical point. Consequently, the latent heat is low, therefore the portion expended for external work is small.

The power required for compression of gases and vapors is in direct proportion to the ratio of initial to final absolute pressure, and to the initial and final absolute temperatures. This can be seen from the following formula:

$$W = \frac{n}{n-1} P_1 V_1 \left[\left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right]$$

W = Work in foot pounds required.
n = An exponent corresponding to the ratio of the mean specific heats during the process.
P_1 = Absolute pressure in pounds per sq.ft. before compression.
P_2 = Absolute pressure in pounds per sq.ft. after compression.
V_1 = Initial volume in cu.ft.

The value of n for CO_2 may be taken, roughly, as 1,262; for ammonia 1.33 will give fairly close results.

There is an idea prevalent that the high pressures encountered, together with the fact that CO_2 does not condense above a temperature of 87.89 deg. F., accounts for the poor showing of carbon dioxide as compared to ammonia. The pressure idea is erroneous, as has been shown. The journal and bearing pressures and sizes are practically the same in a CO_2 machine as they are in an ammonia machine of the same tonnage. It is the absolute pressure ratio that counts, being 3 for CO_2 and 4.4 for ammonia in the case in question. So CO_2 does not suffer on account of high pressure, but is affected by its high liquid heat compared to latent heat.

Dr. Karl von Linde, who has carried out a series of tests, making a direct comparison between an ammonia machine and a CO_2 machine, when both were working under nearly as possible the same conditions, found that when the temperature in the condenser was 72 deg. F. and the temperature of the brine the same in both cases, about 15 deg. F., the coefficient of performance of the CO_2 machine was 82 per cent of the coefficient of the ammonia machine, and when the temperature in the condenser was raised to 95 deg., so as to be above the critical temperature of CO_2 the coefficient of performance was just 50 per cent of that of the ammonia machine working between the same temperature limits.

Dr. Linde further found that if he cooled the condensed liquid to the temperature of the evaporator by a separate machine, whose work was not included in the figures for both refrigerants under test, he got substantially the same amount of refrigeration whether he used ammonia or CO_2.

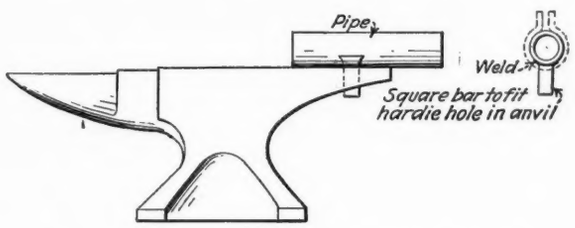
Due to the higher pressure, with consequent smaller vapor volume, the CO_2 machine need not be so bulky as an ammonia compressor to do the same work. Disregarding clearance and volumetric efficiency, the compressor cylinder, to take in one pound of ammonia vapor per stroke, under the cited conditions, must be 24 in. bore and 30 in. stroke, while to take in the same weight of CO_2 vapor per stroke the cylinder need be only 8 in. bore and 9 in. stroke. But to accomplish the same refrigerating effect as the ammonia cylinder, the CO_2 cylinder must be increased to 14 in. bore and 20 in. stroke.

. . . RIGHT OUT OF THE PLANT . . .

Form for Bending Pipe Hangers Fitted to Anvil

IN THE CONSTRUCTION or maintenance of a power plant the blacksmith is called upon to make a large number of pipe hangers or brackets. The usual procedure is to have a helper hold a pipe, around which the iron is bent, on the anvil as a form.

As an improvement on this method we welded on to a 4-in. section of the pipe a square bar 2½ in. long, fitting the hardie hole in the anvil. This arrangement freed



Form for shaping hangers and brackets made from piece of pipe

the helper, allowing him to drill the completed hangers, and at the same time facilitated the smith's work.

The saving in time was so marked that a six-piece set, ranging from ¾ to 3 in., was made up of cold-rolled stock as permanent shop equipment. LOUIS A. BENTON.

South River, N. J.

Restoring Oil-Soaked Insulation

THE ARMATURE windings and field coils of motors with ring-oiled open bearings are almost sure to get oil soaked at some time, even when the oil is maintained at the proper level, as mentioned in the question by "S.W.A." in the Aug. 12 number of *Power*. We have a number of motors of this type that have developed trouble because of oil's getting on the windings, and various methods have been tried for cleaning. The best method to restore the insulation of armature windings and field coils that have become oil soaked is to remove the armature and blow out all free dust with compressed air. A portable paint spray gun attached to a quart jar filled with carbon-tetrachloride is used to blow the liquid on to the windings. This liquid dissolves the oil and grease and removes the dirt quickly and effectively. It dries readily and is less dangerous to use than gasoline or kerosene.

After the carbon-tetrachloride has dried the armature is blown out again with compressed air and the windings are wiped clean. The paint gun is filled with air-drying black insulating varnish, and the armature is given two coats of paint. The paint gun blows the insulating paint into all the openings in the windings that cannot be reached with a paint brush.

The field coils are taken out of the frame, and marked to keep the same polarity. The resistance of each coil is taken to determine if the windings are in good condition. After this has been done, for a distance of about 4 in. along the coil the binding tape is removed and a layer of cotton tape is wound tightly over this space. The cutting and taping process is repeated until the coil has been reinsulated. A small part is done at a time in order to retain the original shape of the coil. Two layers of a good-quality friction tape are wound on the coils and they are given two coats of air-drying insulating varnish. When the paint is dry on the armature and field coils they are assembled in the machine and given a megohm meter test to determine the insulation resistance. W. D. BRISTOW.

Phillipsdale, R. I.

✦

OIL-SOAKED insulation may be restored to approximately its original dielectric strength by a thorough cleaning and drying and immersion in an impregnating, oil-proof varnish. Gasoline can be used for the washing solvent, but carbon-tetrachloride, while more expensive, has the advantage of being non-inflammable. If gasoline is used it must be a straight-run quality. All dirt that can be removed by blowing with air and using a blunt putty knife should be cleaned off before using the gasoline. A small paint brush is about the best tool for scrubbing the armature and the field coils. After a thorough washing the apparatus should be again blown out with compressed air and dried with a rag or oil waste. When the cleaning fluid has dried an insulation test should be made with a megohm meter. A high-voltage test must never be made, as it may puncture otherwise good insulation. The apparatus should be put in an oven and baked to thoroughly dry it out. If the machine is too large to be handled in an oven it may be dried out with space heaters placed in and around it, or by passing a low-voltage current through the windings. After the coils have been thoroughly dried, and while still hot, all parts should be immersed in a tank of oil-proof insulating varnish and allowed to remain there until bubbling ceases. The excess varnish is drained off and the baking process repeated for the length of time required by the varnish used.

The treatment is, in substance, that used on some large steel and iron foundry motors which were water soaked in Pueblo, Colo., during a flood. The windings

were not only soaked with oil and water but also had been allowed to stand idle in that condition for several months before they were given attention. After being treated to restore their insulation they were installed in another foundry of the same company. We have also used this same treatment on pickling-works equipment where the insulation has been injured by the fumes given off by the vinegar and pickling processes.

Denver, Colo. CARL A. WAGNER.

Substitute for Pump Plunger Packing

STEAM-DRIVEN hot- and cold-water pumps often give considerable trouble owing to their piston packing wearing out. Often they are down with no suitable packing available, principally because so little warning is given. This is particularly true when the cylinder becomes pitted.

A good packing substitute may be found in canvas-rubber belting wide enough from which to cut a circle of the diameter of the pump bore. As many circles may be cut as are necessary to fill out the packing space. This belting will not only serve as a substitute, but has been found in some cases to outlast standard packing.

One of our water pumps was packed in this manner more than two years ago, and, although in constant operation since, has not showed signs of needing new packing. We have four pumps ranging in size from 6x10-in. to 8x12-in. pumping 100-deg. water through a heater to boilers operating at 150 lb. pressure.

Butler, Tenn. W. S. WHITING, JR.

Utilization of Sulphite Wastes

I HAVE READ with much interest in the Sept. 16 number a communication from W. Kuhles of Remscheid, Germany, with reference to the utilization of sulphite wastes in pulverized-coal firing.

From my connection both with the News Print Service Bureau and with the Waste Utilization Committee of the American Paper & Pulp Association, I am much interested in any practicable methods for the utilization of sulphite wastes. I agree with Mr. Kuhles that one of the most likely methods for disposing of a large proportion of the waste of the sulphite industry lies in the utilization of the organic matter as fuel. Theoretically Mr. Kuhles' process is interesting, and I am wondering whether he would not make available further information regarding his particular process, especially as regards practical operation. Is the process being used on a commercial scale at the present time, and if so is it possible to secure information regarding the technical and economic factors involved? I am particularly concerned about the initial cost and cost of upkeep of the multiple-effect evaporators operating on unneutralized liquors. Furthermore, there are some practical questions regarding the spray drying of the liquor about which more information than given in the communication is desired.

Any amplification of Mr. Kuhles' method along the lines indicated will be appreciated.

New York City. JOHN D. RUE, *Engineer*, News Print Service Bureau.

Fire Caused by Faulty Installation of Semi-Diesels

THE CAUSE of many operating troubles in power plants can be traced to faulty installation. A rather unusual illustration of this occurred at a power plant of a certain gold-mining company where two 150-hp. semi-diesel engines were belt connected to air compressors. One windy night in January a fire broke out at the power plant and was brought under control only with great difficulty.

In determining the cause of the fire it was found that a wooden box 12x14 in. was used on the compressor intakes, which extended outside of the wall of the building. The box opening was about 10 ft. from the exhaust of the oil engines, and it was evident that hot sparks issuing from the exhausts of the engines had been drawn into the woodbox intakes, thereby causing the fire.

Butte, Mont. RALPH E. MACKAY.

The Consulting and the Operating Engineer

IN THE AUG. 12 ISSUE Mr. Fred Low comments editorially on the consulting engineer and the operating engineer.

The trend of the times now is toward the centralization of power and the general aspect is that, in no distant future, power will be produced and distributed almost entirely by the central station. The days of the private plant appear to be numbered and in reviewing the causes that have brought this condition about, one cannot but be impressed with the fact that some blame may be justly placed upon the shoulders of both the consulting engineer and the operating engineer.

But even in large cities like New York, where the central station is developed to a very high degree, and where steam as well as electricity may be purchased from the utility companies, there are still some private plants operating, for they can produce heat and power cheaper than the central stations can sell it. Some of these plants are over 25 years old, and possess no unusual advantages except that they have a very good operating staff and that the plant was designed by engineers who knew their business. From this it naturally follows that the most of those plants that were replaced by central station service must have been either poorly designed or badly handled.

One factor that has operated heavily against the private plant has been the degree of comfort with which the plant could be operated. Many times boilers and machinery are crammed into spaces that are far too small. Utter disregard is shown for ventilation, or for the comfort of the operator. The result is that overhaul and repairs are difficult to effect; operation is a punishment and a torture, so that good engineers will not stay, and eventually the junk man gets the plant.

The operating engineers have been prone to the fault of being too well content with themselves and can be accused of "lying back in the traces" and of not trying to improve their general knowledge. To open or shut a few valves and throw a few switches appeared to be their sole duties.

Today a private plant must depend on certain essential factors to be able to stand up in competition with the central station. Briefly these factors are: First, that the designer take full advantage of the advances that have been made in engineering practice; second, that the operating engineers be more than ordinary boiler or engine runners—they must know when heat is being lost, and how to stop the loss; they must have enough experience to enable them to operate the plant without causing a heavy amount of repairs to boilers and machinery, and third, the plant must use good fuel, for no plant, however well designed and manned, can produce economical results with inferior fuel.

There appears but one way to ward off the extinction of a profession and a trade that have provided a good livelihood for many in the past, and that is for the consulting engineer and the operating engineer to join hands.

New York City. F. P. MacNeil.

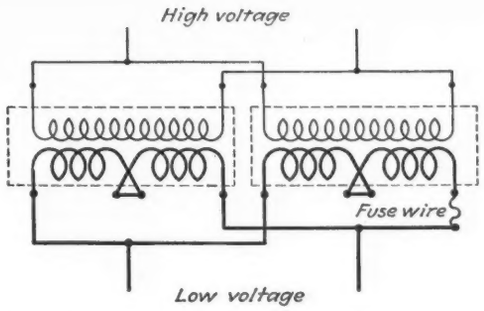
Transformers Connected for Parallel Operation

ALTHOUGH the question on page 470, Sept. 16 number, was answered correctly, I should like to add a few comments. It is seldom advantageous to connect transformers in parallel. Occasionally it may be necessary as a temporary expedient, but where the load requires a greater capacity than that of a transformer already installed, it is preferable to install a larger transformer rather than to supplement the old one by an additional unit of its own size.

Transformers will operate in parallel provided they have the same ratio of transformation, the same voltage ratings and approximately the same regulation. If the low-tension voltages are different, the transformer having the highest voltages will circulate current through those of lower voltage and cause a continuous loss. If transformers connected in parallel do not have the same regulation they will not share the same total load in proportion to their ratings. The greater share of the load will be taken by the transformer having the best regulation.

In connecting very large transformers in parallel, especially when one of the windings is for a comparatively low voltage, it is necessary that the resistance of the joints and interconnecting leads does not vary materially for the different transformers or it will cause an unequal division of load.

When transformers of the same voltage characteristics and capacity are connected in multiple in a secondary network, little trouble will be encountered. The impedance of the line between two transformers on separate poles spaced about 100 or 200 ft. apart will normally neutralize any difference in the transformer impedances. When transformers on the same pole are connected in parallel, the question of equal sharing of the load may be of some importance. Standard transformers of reliable manufacturers do not differ very widely in impedance characteristics, however, and it is usually practicable to operate units of the various standard types in parallel. Often the commercial desirability of paralleling transformers of different sizes will overbalance the undesirability of some inequality in load division that might result.



Fuse wire connected into the circuit to test the polarity of the two transformers

Transformers operated in parallel must have the same polarity at a given instance. To make sure that the secondary terminals connected together have the same polarity, connect the primaries in parallel. On the secondary side connect two of the leads as they normally should be, but in one set include a short piece of fuse wire as in the figure. If the fuse blows when the primary is made alive it shows that the transformers do not have the same polarity and the secondary leads on one transformer must be reversed. If the fuse wire does not blow, the connections can be made permanent.

Harry J. Achee, *Gen. Supt.*,
Hobart, Ind. Hobart Light & Water Co.

The Adjustment Limit of Safety-Valve Springs

IN THE SEPT. 16 ISSUE W.A.D. asks the question: "Is it possible that the setting of safety valves on a boiler, upon changing from a pressure of 125 to 100 lb., may be accomplished without a change of springs, and will it have any effect upon the boiler?"

Evidently the insurance inspector who made the suggestion that the safety valves could be set at a difference of 25 lb. in pressure was not aware of the fact that the efficiency of the safety valves would be greatly hampered. He also evidently came from a state that does not recognize the A.S.M.E. Code or any other boiler code. The A.S.M.E. Code, paragraph 285, specifically reads as follows: "The spring in a safety valve shall not be used for any pressure greater than 10 per cent above or 10 per cent below that for which it was designed."

The manufacturers of safety valves state that there is a range limit to all safety valve springs, and that they cannot have a greater range than 15 lb. above or below the original set pressure without impairing the efficiency of the valve and the regulation of the valve control or amount of blowdown.

It is obvious that the answer given to this question is wrong. I believe that although the question was not expressed as clearly as it might be, that the gist of the question was whether it is proper to set safety valves at a pressure quite different than their original set pressure. I do not think that any damage to the boiler would result from this set from 125 to 100 lb., but more efficiency would be obtained, which in this day and age is an important feature about a modern plant, by installing the proper springs. Charles W. Carter, Jr.

Binghamton, N. Y.

From Among Readers' Problems

Conducted by
L. H. MORRISON

EMERGENCY LIGHTING SYSTEM—*We purchase all power and lighting from the public utility. The management has decided that we should have some system of emergency lights in case our service goes out during the night shift. What is the cheapest system, considering the necessity for automatic control?* P.S.W.

One of the cheapest arrangements would be to run a separate emergency light line through the mill, and install a small waterwheel driven by the city- or mill-water pressure. The throttle of this wheel can be operated by a relay, opening in case the current goes off the relay system. Wheels of this kind are direct connected to small generators, both of the alternating-current and direct-current type.

STOKER FOR SCOTCH MARINE BOILER—*We have two dry-back Scotch marine boilers used for heating purposes. At present we hand fire but wish to install some form of stoker. Would it be safe to fire in the round furnace or would a Dutch oven be necessary? We are burning a high-volatile coal.* J.Y.

Probably it would be cheaper to install a unit-type underfeed stoker to fire directly in the furnace tube. But since high-volatile coal is used, better combustion will be had if a mechanical stoker is installed in a Dutch oven in front of the furnace.

SAVING BY CORING PISTON—*What effect has the weight of a piston on the steam consumption of an engine? For example, if the weight of a piston be decreased 30 per cent by being cored, everything else remaining the same, what would be the reduction in per cent in steam consumption of an engine with the lighter piston?* A.W.G.

Engine friction varies, but a good modern engine should show a mechanical loss of not over 6 per cent. Of this about one-half is piston friction, or 3 per cent of the total developed horsepower. By reducing the weight 30 per cent, the piston friction should not be reduced more than 30 per cent, or the reduction would be 1 per cent of the engine's indicated power. If the engine had a steam rate of 30 lb. per indicated horsepower-hour, the saving would be 0.3 lb. per horsepower-hour.

The piston should be cored instead of solid, at all events, for the saving in ring wear justifies it.

PRESSURE LOSS IN BENDS—*Is it a fact that a square bend offers less resistance to air flow than a rounded bend?* A.F.C.

The turbine department of the General Electric Company conducted a series of tests the results of which proved that the square duct offered less resistance, or that to pass the same amount of air the square duct requires less initial pressure. If the square duct is provided with internal vanes, or louvers, the resistance is still less.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

WE HAVE a 200-ft. smoke stack, stack and breeching designed to ultimately serve six 4,000-sq.ft. boilers having underfeed stokers and forced draft. With only two boilers in service we have 1¼-in. chimney draft. This carries a large amount of fly ash out of the stack, causing complaints from residents in the neighborhood. We operate with dampers nearly closed, as we need only 0.1 to 0.2 in. draft over the fire.

Can this fly ash be prevented from going out of the stack? J.J.H.

UNLESS a scrubbing or separating appliance is interposed between the boiler and the stack, natural gravity alone is left to cause a depositing of ash in the stack or breeching.

Velocity carries the ash out, and this velocity depends on the difference between the pressure of the column of hot gas in the chimney and the column of cold air outside.

Assuming an economical temperature of chimney gas of 350 deg. F., the density of mixed gases is about two-thirds that of air, at this temperature, and the difference in pressure of columns inside and outside of chimney is one-third of the weight of a column of air of the height of the chimney.

The velocity of air flowing into such a chimney and meeting no resistance over that caused by gases is equal to that of a body falling freely through a distance of the difference in the heights of the columns, one column, of course, being of cold air the height of the chimney and the other column being considered as cold air two-thirds the height of chimney.

These being the fundamentals, and since the boilers and chimney are already in place and unalterable, the only alternative is to reduce the temperature in the chimney. The cheapest method is the one mentioned in the query, to admit cold air in the opening in the breeching.

A partition with a one-half brick manhole should be built across the interior of the chimney base to reach above the top of the inlets and separate the inlets from the boilers and the cold air inlet; to prevent baffling the draft, the opening for the cold air should be as large as possible to reduce the velocity.

J. S. STEVENSON.
Los Angeles, Calif.

THE most successful way to combat the fly ash nuisance would be to install a cinder catcher. There are several makes on the market that would satisfactorily remove a sufficient percentage of the fly ash to prevent its being a nuisance.

The carrying power of the gases is a direct function of their velocity. Therefore a reduction in velocity will reduce the amount of fly ash emission from the stack. Passing the flue gases through a chamber of sufficient size to materially reduce their velocity will help precipitate the larger particles of ash, but often such an arrangement is not practical by reason of lack of room.

Reduction of stack draft, while it may be effective in preventing discharge of fly ash, does so primarily because it reduces leakage into the breeching between the boiler damper and the stack. Such leakage increases the quantity of gas, hence, its velocity and its carrying power. Reducing the draft by opening the end of the breeching would reduce the leakage into the breeching and permit depositing some of the fly ash in the breeching, but it would have little effect in increasing the amount deposited in the base of the stack.

It would be a better plan to make an opening in the stack above the breeching entrance. Then not only the entire breeching, but also the section of the stack below the opening, would be included in the area of reduced suction and therefore available for the deposition of fly ash. The opening in the stack should be provided with a damper, preferably controlled automatically by the suction in the breeching, to hold the suction constant regardless of rating.

It would be well to go back to the reason for fly ash entering the stack in the first place, and if possible eliminate that cause before applying corrective devices.

Fly ash results from blowing the fuel or ash off the grates of the stoker. Up to a certain rating the fuel will burn on the grate. As the rating is increased the increased forced-draft pressure tends to lift the fuel bed off the grates. It is therefore well to hold the rating below this point, adding more boilers if possible. The condition of the fuel bed has a bearing on the point where the fuel will be raised by the air pressure. A fuel bed full of holes will permit more fly ash to be blown into the boiler and thence to the stack. A good fuel bed will permit higher ratings without fly ash nuisance than a poor fuel bed.

The next point to be examined is the breeching and its connections. A leaky breeching permits infiltration of air, increasing the velocity of the gases and, therefore, their carrying capacity. Much may be done to reduce the fly ash passing out of the stack by sealing all joints and connections in the breeching. Particular attention should be paid to the dampers in idle boilers. These usually do not fit tightly and considerable air will leak through them, thereby increasing the velocity of the gas in the breeching.

Be sure that operation and equipment are correct; then consider the advisability of installing dust catchers, of reducing the stack draft, or of other methods.

JAMES W. ARMOUR,
Engineering Manager,
Riley Stoker Corporation.
Worcester, Mass.

ONE WAY to eliminate fly ash is to employ an enlargement in the breeching or flue to reduce the velocity of the gases sufficiently so that fly ash will be deposited or precipitated.

Water sprays are being used in some instances for washing out the fly ash, and there is a centrifugal mechanical process for extracting the fly ash.

Another method, which I recently proposed to an American manufacturer of wire cloth, is to place wire cloth in the flue of so fine a mesh that the fly ash cannot get through. This manufacturer produces the finest wire cloth in the world, 400 mesh, or 160,000 square openings per square inch. Fly ash certainly would not get through a screen as fine as that. But I dare say that a 400-mesh wire cloth would not be necessary. Besides, the 400-mesh variety, so fine that it holds water, is rather costly.

The wire-cloth manufacturer questioned the practicability of wire cloth. It might be found necessary to renew the wire cloth frequently owing to sulphur in the gases, for sulphur is a hard customer for many metals to resist. Some means would have to be provided for keeping the meshes open, but such things are done in connection with cooling water for condensers and I have no doubt but that it can be used to keep fly ash out of the atmosphere. Spark arresters are used in steam locomotives and threshing engines—Why not "fly ash arresters" in power plant stacks?

W. F. SCHAPHORST.
Newark, N. J.

THE fly ash trouble is due, no doubt, to the excessively high velocity of the gases through the constricted area around the nearly closed damper, which provides the ash particles with sufficient energy to enable them to be carried up the chimney rather than be deposited at the bottom. The solution of the problem is to reduce the velocity. The gas velocity varies, among other factors, directly as the gas temperature and inversely as the area of passage. Since the latter must of necessity remain practically constant, the only alternative left to reduce the velocity is to decrease the gas temperature by the admission of air to the gas stream on the boiler side of the damper. This not only reduces the velocity but also decreases the available draft intensity, with the result that less constriction by the damper is required.

It should be remembered that the high velocity is not in the chimney, but past the damper, where the gas passage area is constricted. Neither a tall chimney nor a high draft intensity necessarily indicates a high velocity. Therefore, if a damper were installed in the chimney above the breeching entrance, the same problem would be introduced as exists in the breeching, that is, the area in the chimney would be constricted and the gas velocity would be excessively high. In both cases the high velocity imparts sufficient kinetic energy to the ash particles so that they go up and out of the chimney before the force of gravitation is able to overtake them.

Therefore, the only solution I see to the problem is to reduce the velocity by lowering the gas temperature.

Indianapolis, Ind. J. G. MINGLE.

A Question for Our Readers

I FIND on taking charge of a heating system that a water spray is used ahead of the vacuum pump. Is this good practice and why is the spray necessary? R. R. C.

Suitable answers from readers will be paid for and published in the Nov. 25 number

I DO NOT THINK that the method proposed would be entirely satisfactory, but owing to its one advantage, cheapness, it is a suggestion that would be worth carrying out.

Between the damper and the chimney a set of dampers should be placed in the sides of the breeching. These excess-air inlet dampers should be capable of fine control and should reduce the gas velocity to a point where the fly ash will settle, and provision should be made to dispose of the fly ash from the breeching.

Should this arrangement not be successful I suggest the installation of a grit arrestor, either of the rotary or irrigated-baffle type, to deal with the gases.

The fact that six boilers are to be ultimately installed will not help the final draft conditions to any marked extent, and under certain conditions would aggravate the fly ash nuisance.

T. H. PARDOE.
Wolverhampton, England.

EFFECTIVE precipitation of fly ash depends upon sudden changes in direction of travel and reduced velocity of the sustaining gases.

For this reason the addition of air to a flue system of a boiler plant will aggravate rather than remedy any dust nuisance, as the density and volume of the gases will be increased.

The first corrective measure should be the elimination of all appreciable leaks in either the boiler settings or the flue walls so as to reduce the gas volumes and velocities to a minimum.

Water sprays installed in the stack might be sufficiently effective to give the desired effect.

However, since in this instance there is appreciably more draft available than required, cinder traps could be used effectively, because the attendant draft drop would not be so prohibitive as usually is found to be the condition when sufficient sections are installed to do a good job. R. S. LANE.
New York City.

Water Power a Live Topic At A.I.E.E. Convention

Hydraulic and electrical possibilities of high-speed low-head hydro-electric units, trends in design and capacity of large waterwheel generators, automatic economy control as applied to hydro-electric plants, and a new system of speed control of alternating current motors for steam power-plant auxiliaries were some of the subjects considered.

THE Benjamin Franklin Hotel in Philadelphia, Pa., was the headquarters for the sixth meeting of the Middle Eastern District of the American Institute of Electrical Engineers, held Oct. 13 to 15. At the five technical sessions there were presented 22 papers on a wide range of engineering subjects, including hydro-electric power, railroad electrification, substations, speed control of alternating-current motors, lightning protection, transformers with load ratio control, design of electrical power equipment, and other tracts of interest to power and electrical engineers. Two sessions, one on hydro-electric power and one on electrical equipment, were of particular interest to power engineers.

The hydro-electric-power session was held on Monday afternoon and was presided over by Lyle A. Whitsit. At this session four papers were presented. The first, by George A. Jessop and C. A. Powell, was on "Hydraulic and Electrical Possibilities of High-Speed Low-Head Developments." Attention was called to the change brought about in hydro-electric practice by the introduction of high-speed, low-head, propeller-type turbines. Because of the economy in first cost, a great deal of effort has been expended, during the past twenty years, to secure high-speed units. The principal reduction in first cost has been in the generator as the speed increases, the hydraulic turbine costs decreasing to a less extent. Until recently the increase in speed in hydraulic turbines has resulted in a decrease in efficiency, particularly at part loads, which to a large extent offset the advantage of reduced investment. Improvement in generator efficiency with increased speed only partly compensated for the reduced turbine efficiency. Turbine designers have now succeeded in maintaining the maximum efficiency over a wide range of specific speeds and by means of the Kaplan, or automatically adjusted, blade runner have improved the part-load efficiency above that formerly obtained with slow-speed Francis turbines.

The field of application of the fixed- and adjustable-blade axial-flow turbine is placed at heads of 70 ft. or less. The speed of this type may be 70 or 80 per cent higher than that of the medium-speed Francis turbine and the reduction in cost about 5 or 10 per cent. Both types of wheels have to handle approximately the same amount of water, which accounts for the small reduction in cost for the high-speed type.

There is an advantage in increasing the generator's speed, since its cost goes down and its efficiency increases. As an example of reduction in cost, a 12,500-kva., 300-r.p.m. generator will cost about one-half that of the same size of machine designed for 80 r.p.m. The cost of the adjustable-blade turbine was given as 20 to 25 per cent higher than for the fixed-blade type for large sizes and as much as 50 per cent higher for small sizes. However, the adjustable-blade type gives a large increase in kilowatt-hour output over the fixed-blade machine and therefore is a greater revenue producer. In a comparison made of a plant having three 28,500-kw., 53-ft.-head units of either the Francis, fixed-blade propeller or adjustable-blade types the latter showed 11 per cent greater kilowatt-hour output than either the Francis- or the fixed-blade propeller types.

THE SECOND paper on the Monday afternoon program was "Trends of Design and Capacity of Large Hydro-Electric Generators," by M. C. Olson. Figs. 1 and 2, taken from the paper, show the trend in capacity of large vertical and horizontal types of hydro-electric units during a period of 30 yr. The largest units shown in Fig. 1 are the 77,500-kva. generators being built for the Dneiper River hydro-electric development in Russia. These machines will be the world's largest hydro-electric units, both as to rating and physical size. In Fig. 2 the largest unit shown is the 55,000-kva., 360 r.p.m. generator now being built for the Sao Paulo Tramway Light & Power Company, Brazil. This generator will be driven by a double overhung waterwheel.

Radical changes have been made in the design, construction and appearance of waterwheel-driven generators during the last few years, as a result of the use of rolled steel plates and fabricated structures in place of castings. With the introduction of welded steel-plate construction, generators have been made more reliable mechanically, lighter in weight, and much more adaptable for special ventilating or constructional requirements. Also, deliveries have been made possible in a shorter time.

So many advantages are obtained with the inclosed system of ventilation that there is a decided trend toward this method. One of these advantages is clean windings. Attention was called to the temperature of a 12,222-kva. vertical generator before and after cleaning. At full load the temperature of the winding was 11 deg. C. cooler after cleaning than before.

"AUTOMATIC Operator for Economy Control Applied to Hydro-Electric Stations" was the title of a paper presented by S. Logan Kerr. It dealt with the great importance of economic division of load between various units in a hydro-electric plant and the proper combination of units for any given output allowing for the proper reserve required. It pointed out that, in the past, the attempt to achieve ideal economy of operation has been handicapped by the human element. Studies have shown that where the efficiency of a plant was 90 per cent on test, only 80 per cent was realized in operation. The solution for this problem has been found in the development of an automatic operator, designed specially for each plant and adapted to the particular system requirements, and the installation of special automatic control equipment which permits rigid enforcement of ideal schedules.

A description was given in the paper of the automatic operator used in the Norwood plant of the Carolina Power & Light Company and in the Morony plant of the Montana Power Company. The latter will be published in the October 28 number of *Power*, along with H. A. Von Eiff's discussion on this paper, dealing with operating spare capacity in hydro plants as synchronous condensers.

Carrol F. Merriam, discussing the paper, called attention to the possibility of using flood water by means of head increasers, such as the ejector turbine and backwater suppresser. He said it is entirely possible that when the principles of the ejector are better understood there will be found many applications for these means of getting increased capacity during times of flood. Another problem which may at first appear paradoxical is the economy of spilling water over a fixed-crest dam at times of insufficient flow. With a sharp peak during the early hours of hydro generation, a short spillway, and

especially if in order to accommodate the steam plants the pond is drawn down weekly and the maximum elevation is reached but once a week, there can be shown to be an appreciable saving by securing higher average head even though the pond is allowed to overflow a few tenths of a foot.

The concluding paper of the session "Damper Windings for Waterwheel Generators," was presented by C. F.

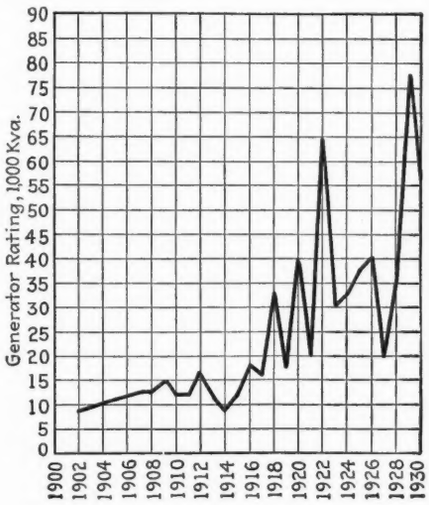


Fig. 1—Trends in capacity of large vertical hydro-electric units

Wagner and discussed the effects of amortisseur, or damper winding, upon both the real and reactive components of the negative sequence impedance. The conclusions were drawn that the choice of the most appropriate damper winding is dependent upon the emphasis to be placed upon the different characteristics. The desirable property of rapid damping associated with copper dampers should be of value only in special cases in which there is danger of compound oscillations of such character that pullout occurs on the second or third oscillation. When pullout does take place it usually occurs on the first swing. High-resistance dampers should be of value regardless of the nature of the oscillations, and from this viewpoint are more desirable. Double-deck or similar dampers are somewhat of a compromise, conferring to the machine some damping characteristics, and at the same time increasing the stability limit because of the increase in power absorbed by the damper.

AT THE TUESDAY morning session, R. A. Hentz presiding, a paper "Outdoor Switching Equipment at Northwest Station of the Commonwealth Edison Company," by W. F. Sims and C. G. Axell, described the switching equipment and arrangement in an outdoor switching center at 132, 66 and 12 kv. in connection with an installation of 3-wire transformers. The development of the original 12,000-volt installation was with indoor-type equipment inclosed in metal housings and concrete cells. Space limitations and the rising cost of buildings led to making the extension to the 12,000-volt switch station outdoors. Two types of 12,000-volt outdoor switching equipment have been installed. One is metal, housed in concrete cells, and the other is metal-clad, oil-filled. The metal-housed equipment has been in service for about three years and the metal-clad oil-filled for about eight months. Operating experience with both installations was reported to be so far entirely satisfactory and, with the possible exception of maintenance difficulties under severe weather conditions, as convenient as an indoor installation. The degree of safety both to life and service that can be secured in the outdoor design is as high as that in an indoor installation. The distance by which adjacent phases may be separated is such that the liability of trouble spreading is much less than would be the case in a similar installation located in a building. Preliminary estimates had indicated the possibility that a 12,000-volt outdoor installation should cost less than one indoors, with the cost of building included. Exact comparisons are difficult to make because of varying conditions on different projects.

"A New System of Speed Control—A. - C. Motor - Driven Power - Station Auxiliaries," was the title of a paper by A. M. Rossman that described a new system for controlling the speed of alternating-current motors. An abstract

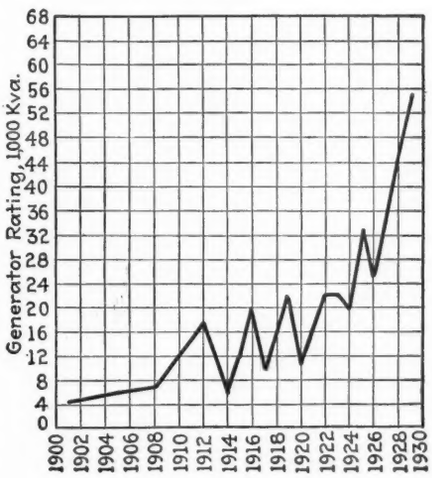


Fig. 2—Trend in capacity of large horizontal hydro-electric units

from this paper appears on pages 662 and 663 in this number.

In the discussion attention was called to two units each of 2,500 hp. capacity and a speed range of 2 to 1 for driving reciprocating boiler-feed pumps. One of the advantages claimed for the new equipment is the use of machines that operators are familiar with. Comparisons made in the paper with other types of drives for adjustable-speed auxiliaries showed the advantage in favor of the new type of drive. In the discussion, figures were given that were obtained from a study made of drives for 22 boiler draft fans, each requiring 600-hp. vane-control fans and two-speed squirrel-cage motors to give speeds of 1,160 and 870 r.p.m. showed the lowest annual operating cost. Using the new systems of speed control and common type dampers, the annual costs were 32.4 per cent higher. It was brought out that one of the reasons for the higher cost of the new systems was that the drive had been designed for a particular fan speed rather than selecting a fan and motor speed that would give the most economic combination. As a result of not doing this the direct-current machine had a capacity equal to 33⅓ per cent of the alternating-current motor, when it could have been made 13.5 per cent.

Load Ratio Control

The paper, "Transformers With Load Ratio Control," by Arthur Palme, described and compared with earlier developments a novel equipment of low-current rating that has been devised especially to control small blocks of power, thereby greatly extending the economic field of load ratio control applications to transformers. The cost of the necessary electrical and mechanical accessories to permit changing of taps under load is an appreciable percentage of the over-all cost of the transformer. With a given and standardized mechanical equipment, the cost of the load-ratio-control apparatus proper does not change materially with the amount of power it has to handle. This means that the smaller the rating of the machine to which it is applied, the higher its cost in per cent of that of the whole transformer. Considering, however, the many operating advantages which the installation of such a machine affords, this increase seems sound and justified, provided the output of the transformer is not too small. Experience and past demand indicated that the majority of transformers equipped with load ratio control were of such size that the current to be handled by the selector switches and interrupting device was between 500 and 1,000 amp. Consequently a line of apparatus was developed suitable for this range of current and for circuit voltages from 15,000 to 73,000.

The main difference between the heavy-current type and the new equipment for lower current and voltage is in the simplified type of selector switch, a smaller type of oil-immersed contactors and a smaller motor drive. The new equipment is limited to 400 amp. In its design the electro-dynamic stresses in case of a short circuit have been eliminated by making the contact clips grip the blade on both sides. Tests made with over 25 times normal current (more than 10,000 amp.) showed neither welding nor sputtering.

Experience has shown that the forces on turbine-generator armature windings during short-circuit conditions are high. The windings may be seriously damaged if they are not adequately braced and supported. In a paper "Forces in Turbine-Generator Stator Windings," J. F. Calvert gave three methods of figuring the forces exerted on current-carrying conductors.

Adjustable-Speed Drives With A.-C. Motors*

A new system of controlling the speed of alternating-current motors is being used in some of the important power plants, on induced-draft and forced-draft fans, and on boiler-feed pumps. A cost analysis shows that the new system has advantages over other methods of obtaining adjustable speed

By A. M. ROSSMAN
Research Engineer
Sargent & Lundy, Inc.

THIS ARTICLE discusses the practical application of a new system of speed control for alternating-current motors described in *Power*, Aug. 19 number, under the title of "A New System of Speed Control for Alternating-Current Motors." The system consists of a drive unit and a regulating unit. The drive unit comprises a constant-speed alternating-current motor of either the synchronous or induction type, supplemented by an adjustable-speed direct-current machine of much smaller size. The frame of the alternating-current motor is mounted on bearings so that the frame as well as the rotor may rotate. The direct-current machine, which is shunt wound and separately excited, is mechanically connected to the frame of the alternating-current motor so that it may drive or be driven by the frame. The direct-current machine is electrically connected through a motor-generator set or regulation unit driven from the alternating-current power source. Fig. 1 is a diagram of the speed-control system.

The speed of the driven machine is increased above the fixed speed of the alternating-current motor, which may be called the base speed, by causing the direct-current machine to act as a motor and drives the frame of the former in the same direction as the rotor. The speed of the rotor's shaft is then the sum of the base speed plus the frame speed. To decrease the rotor's speed below the base speed, the frame of the alternating-current motor is caused to act as a motor to drive the direct-current machine as a generator in the direction opposite to that of the rotor. A shaft speed is obtained that is the difference between the base speed and the frame speed. The direct-current machine then delivers energy through the motor-generator set back into the alternating-current system.

Where this system is used to drive fans or centrifugal pumps, machines in which the power is a function of the cube of the speed, the speed range may be extended beyond that attainable by armature voltage control, by weakening the field of the direct-current drive machine.

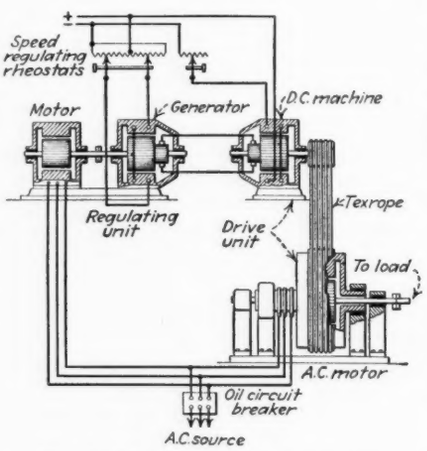


Fig. 1—Diagram of the new system of adjustable-speed drive

Table I shows the maximum operating speed of the fan or pump corresponding to the two variables which determine it, namely: (1) the speed of the induction motor; (2) the speed range of the load. This table also shows the relative ratings of induction motors and direct-current machines corresponding to each range of speed. Attention is directed to the wide range of speed that can be obtained from a comparatively small percentage of direct-current machine rating in the drive unit. For example, a speed range of 100 to 50 per cent is obtained with a drive unit in which the rating of the direct-current machine is but 13.3 per cent of the total. If the alternating-current motor were of the synchronous type the rating of the direct-current machine would be but 12.5 per cent of the total.

Extension of the speed range by field control is not practicable where the horsepower varies directly with the speed; the full speed of the alternating-current motor then becomes the midpoint between maximum and minimum shaft speed.

An extensive installation of this system of speed control is now being made in the power station of the Super Power Company of Illinois at Powerton, Ill. Here the forced- and induced-draft fans of six boilers are driven by motors which operate on this system. Each boiler has two forced-draft fans and two induced-draft fans, and each fan has its own independent drive unit. The alternating-current motors of the drive units are of the squirrel-cage induction type. One motor-generator set controls the two forced-draft fans of each boiler, while a second motor-generator set controls the two induced-draft fans. The principal data pertaining to this installation are given in Table II.

The curves of Fig. 2 show the division of load between the alternating-current motor and the direct-current machine over the speed range of the forced-draft fans. Fig. 3 shows similar curves for the induced-draft fans. These curves also show how the total speed range is apportioned between armature voltage control and field control of the direct-current-drive machines. On the forced-draft fans one-half the speed range is obtained by armature voltage control and one-half by field control, whereas on the induced-draft fans two-thirds is obtained by armature voltage control and one-third by field control. The relatively small proportion of direct-current machines is reflected in the rating of the conversion equipment which, as shown by Table II, is but 1,140 kw. in motor-generator set

*Abstract of a paper "A New System of Speed Control for A.-C. Motors," presented before the American Institute of Electrical Engineers, Philadelphia, Pa., Oct. 13 to 15, 1930, meeting.

TABLE I—DATA ON FAN AND CENTRIFUGAL PUMPS, ON WHICH THE POWER VARIES AS THE CUBE OF THE SPEED

Speed range—100 per cent to		95	90	85	80	70	60	50	40	30	20	10
Speed reduction in per cent of max., per cent		5	10	15	20	30	40	50	60	70	80	90
Relative ratings of machines of the drive unit	A-c.	97.4	95.1	93.2	91.6	89.5	88.7	86.7	84.1	81.6	79	76.5
	D-c.	2.6	4.9	6.8	8.4	10.5	11.3	13.3	15.9	18.4	21	23.5

Induction Motor		Maximum Operating Speed of Fan or Pump										
Syn. Speed	Full Load Speed											
1800	1750	1800	1840	1880	1920	1960	1975	2025	2080	2150	2210	2300
1200	1160	1190	1220	1245	1270	1300	1310	1340	1380	1425	1470	1520
900	870	890	915	935	955	975	985	1005	1030	1065	1100	1135
720	690	710	725	740	755	775	780	800	820	850	875	905
600	575	590	605	615	630	645	650	665	685	705	725	750
514	490	505	515	525	535	550	560	570	585	605	620	640
450	430	445	455	465	475	485	490	500	515	530	550	565

capacity to control 7,020 hp. in motor capacity. An induced-draft fan having a maximum speed of 1,004 r.p.m. would have still further reduced the rating of the motor-generator set capacity, but as the fans and building steel were on order for some time before it was decided to install this system of fan drive, the change was not regarded as practicable.

The reasons for installing this system of driving the fans at Powerton were:

1. Simplicity and smoothness of the method of speed control.
2. The energy saving due to the high efficiency of the method of control.
3. The new system can be installed at nearly the same cost as the system previously used.
4. The ease with which the system may be adapted to automatic combustion control.
5. The successful experience with two 300-hp. units of this type installed at State Line power station.

Various types of motors have been used for driving forced- and induced-draft fans. The motors most commonly used are of the induction type, in both squirrel-cage and slip-ring forms. As the draft fans on the boilers previously installed at Powerton are driven by two-speed squirrel-cage induction motors, the comparisons in this article are made between the new system and that type of motor.

Comparisons of the two systems are based on the installation of two 105,000-kw. turbine-generator units, designated units Nos. 3 and 4, respectively, which are now being installed at Powerton. Steam for each unit is furnished by two boilers of standard type and one boiler of the reheat type. The load curve for units 3 and 5 is assumed to have the same shape as the load curve for present units 1 and 2, each rated 52,500 kw. but increased in direct proportion to the increase in generating capacity.

An analysis of the application of this system to the fans of the six new Powerton boilers shows a distinct saving in energy consumption. An annual estimated saving of the new drive over the old for the twelve forced- and twelve induced-draft fans of four standard boilers and two reheat boilers is $13,315 when power costs 0.3c.; $17,754 when power costs 0.4c., and $22,193 when power costs 0.5 cent.

Energy savings of this magnitude usually call for a considerable additional capital expenditure. In this instance such is not the case. Estimates show that the savings in miscellaneous accessory equipment required by the old system but not by the new nearly offset the higher cost, including development of the drive units and motor-generator sets of the new system, as shown in Table III.

The system of driving forced- and induced-draft fans is also being installed in the Philo power station of the Ohio Power Company, and in the Sheboygan power station of the Wisconsin Power & Light Company. In these plants the alternating-current motors are designed to operate at 2,200 volts, three phases.

An analysis was made of the problem of driving a centrifugal boiler feed pump by the new system compared with using induction motors of both squirrel-cage and slip-ring types. The speed range was assumed to be 100 to 85 per cent for the motors of the adjustable-speed type. The analysis gave the following results:

While the investment costs of the slip-ring and squirrel-cage motor drives were both lower than the cost of the new system, the total annual cost, which included both investment and operating costs, favored the new system. It was therefore decided to install this system of drive on one boiler feed pump at Sheboygan power generating station in Wisconsin.

TABLE II—PRINCIPAL DATA ON THE POWERTON FORCED- AND INDUCED-DRAFT FAN DRIVES

	Forced-Draft Fans	Induced-Draft Fans
Number of fans	12	12
Number of drive units	12	12
Maximum fan speed	1004 r.p.m.	1088 r.p.m.
Minimum fan speed	452 r.p.m.	435 r.p.m.
Range of fan speed	100 to 45 per cent	100 to 40 per cent
Constant-speed component (a.-c. power) at maximum fan speed	141 hp. at 860 r.p.m.	330 hp. at 860 r.p.m.
Adjustable—speed component (d.-c. power) at maximum fan speed	25 hp. at 144 r.p.m.	89 hp. at 228 r.p.m.
Total power at maximum fan speed	166 hp. at 1004 r.p.m.	419 hp. at 1088 r.p.m.
Speed of d.-c. machine at maximum fan speed	Plus 625 r.p.m.	Plus 625 r.p.m.
Speed of d.-c. machine (operating as a generator) at min. fan speed	Minus 1,875 r.p.m.	Minus 1,250 r.p.m.
Ratio of ratings—d.-c. machine to a.-c. motor	14.5 to 85.5	21 to 79
Number of speed-regulating motor-generator sets	6	6
Rating of each speed-regulating motor-generator set	40 kw.	150 kw.
Total rating of all drive units		7,020 h.p.
Total rating of all speed-regulating motor-generator sets		1,140 kw.

TABLE III—ESTIMATED COST PER BOILER OF FAN-DRIVE AND DRAFT-CONTROL EQUIPMENTS FOR THREE DIFFERENT SYSTEMS FOR POWERTON UNITS 3 AND 4

	Existing Systems: Damper System (2-Speed Motors)	Existing Systems: Inlet Vane System (2-Speed Motors)	New System: Adjustable Speed Drive
Fan motors:			
2—Induced draft-fan motors	$ 5,500	$ 5,500	$13,400
2—Forced draft-fan motors	3,300	3,300	8,300
—Supports and enclosures	....	....	400
—Installation	800	800	2,000
—Circuit breakers and control, installed	5,000	5,000	6,650
1—Exciter motor-generator set	....	....	550
—Speed selector switches for four fans	6,000	6,000	....
—Installation	1,100	1,100	....
—Power and control cable and conduit, installed	2,000	2,000	3,000
	$23,700	$23,700	$34,300
Vanes and dampers:			
2—Sets vanes or dampers with mech. (ind. dft.)	$ 600	$ 2,000	$ 600
2—Sets vanes or dampers with mech. (fcd. dft.)	600	1,300	600
—Installation	300	1,050	300
2—Damper drive units	4,250	2,400	....
—Installation	360	360	....
—Cable and conduit, inst	2,000	2,000	....
	$ 8,110	$ 9,110	$ 1,500
Fan speed-change accessories:			
4—Centrifugal relay switch equipments	$ 425	$ 425	....
2—Centrifugal relay switch equip. (for interlock)	215	215	....
—Installation	760	760	....
—Wire and cable, inst	800	800	....
	$ 2,200	$ 2,200	
Total cost per boiler	$34,010	$35,010	$35,800

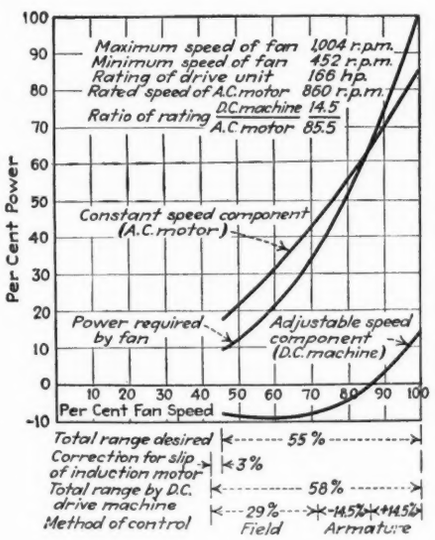

Maximum speed of fan 1004 r.p.m.
Minimum speed of fan 452 r.p.m.
Rating of drive unit 166 hp.
Rated speed of A.C. motor 860 r.p.m.
Ratio of rating D.C. machine / A.C. motor 14.5 / 85.5
Constant speed component (A.C. motor)
Power required by fan
Adjustable speed component (D.C. machine)
Per Cent Power
Per Cent Fan Speed
Total range desired 55%
Correction for slip of induction motor 3%
Total range by D.C. drive machine 58%
Method of control
29% Field
-14.5% +14.5% Armature

Fig. 2—Power curves for forced-draft fans

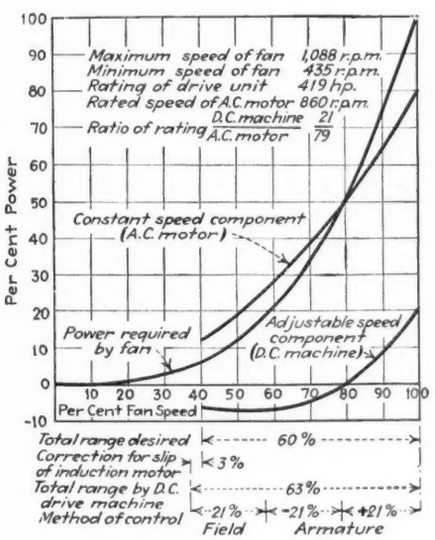

Maximum speed of fan 1,088 r.p.m.
Minimum speed of fan 435 r.p.m.
Rating of drive unit 419 hp.
Rated speed of A.C. motor 860 r.p.m.
Ratio of rating D.C. machine / A.C. motor 21 / 79
Constant speed component (A.C. motor)
Power required by fan
Adjustable speed component (D.C. machine)
Per Cent Power
Per Cent Fan Speed
Total range desired 60%
Correction for slip of induction motor 3%
Total range by D.C. drive machine 63%
Method of control
21% Field
-21% +21% Armature

Fig. 3—Power curves for induced-draft fans

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Heat Exchanger With Flow-Distributing Plate Valve

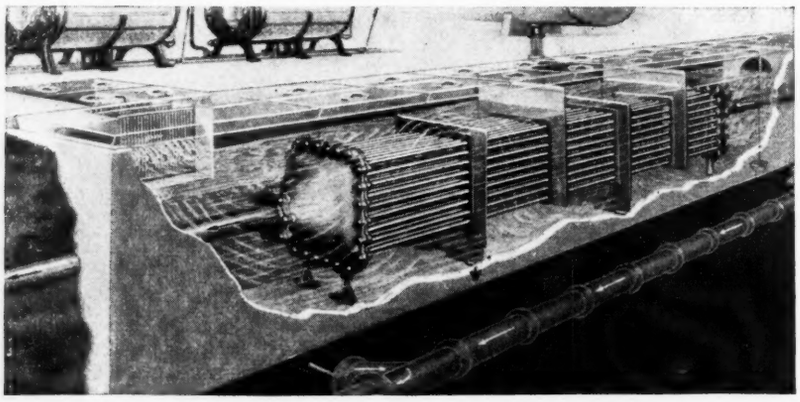


Fig. 1—Typical installation of Gebhardt heat exchanger

AN IMPROVED TYPE of heat exchanger designed to obtain high heat transfer has been brought out by the Gebhardt Company, Inc., 343 Dearborn St., Chicago. Full and equal use of each tube, in securing an interchange of heat from outgoing hot drain water to incoming water for process, is obtained by a water spreader plate valve placed at the receiving end of the exchanger. The flat plate valve is machined on the inner surface so that it will fit tightly against the ends of the tubes. For each tube the valve plate has a hole of corresponding diameter. From outside the casing, horizontal adjustment of the plate can be made to uncover the tube ends to a point where the aggregate of the free openings will correspond with the average flow through the unit. In this way the flow through each tube is practically uniform.

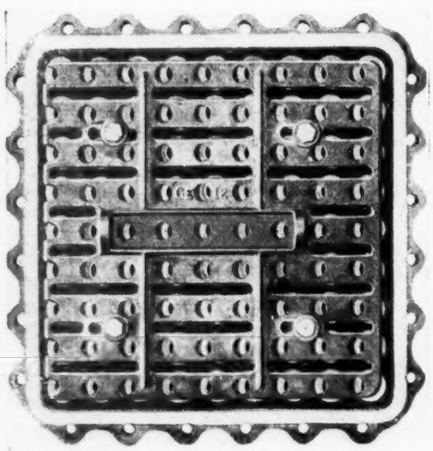


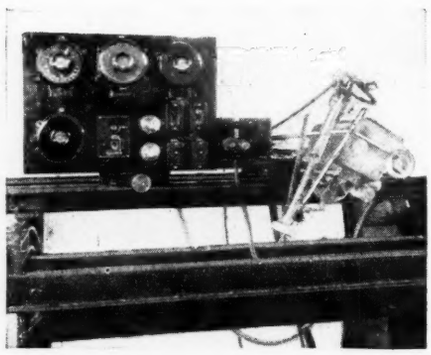
Fig. 2—Plate valve at receiving end of exchanger

The accompanying installation view shows the exchanger applied to laundry service. It has been placed in a concrete trench under the floor. The catch basin and screen chamber remove the heavy particles of waste material from the hot drain water as it flows into the trench. Baffles across the exchanger, carried alternately to the floor and to the top of the trench, direct the flow of the outgoing water across the surfaces of the tubes to keep them free from the insulating air globules that will form. The water to be heated passes counter-current through the tubes. To withstand the acids or caustics that may be encountered in water of this character, the tubes are of copper and the baffles and end castings of acid- and alkaline-resisting bronze. Tubes of 1-in. diameter are spaced in vertical and horizontal rows on 2-in. centers. The tubes may be from 6 to 20 ft. long. Capacities range from 1,000 gal. per hour up.

Automatic Atomic Hydrogen Welding Machine

TO BROADEN the application of atomic hydrogen welding which heretofore has been used for hand welding only the General Electric Company, Schenectady, N. Y., has brought out a new automatic welder designed for longitudinal seam welding of all kinds. It consists of a clamping mechanism for holding the work, an automatic travel carriage, a welding head and the usual control devices. The clamping mechanism and carriage are of standard types, while the welding head, control, etc., are of special design. In addition there is an auxiliary feeding device for feeding filler rod into the arc.

With the pressing of the "start" button the line contactor closes, applying power to the equipment and simultaneously opening a valve supplying hydrogen to the arc. The striking of the arc, movement of the travel carriage and length of the arc are all controlled automatically. Alloys containing chromium, aluminum, silicon or manganese can be welded without fluxes and without surface oxidation.

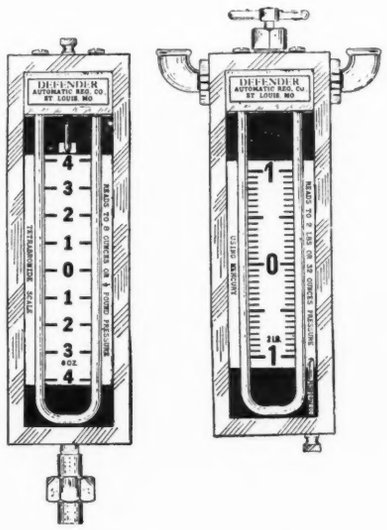


Machine with welding head raised from the welding position

Line of U-Gage Manometers

A COMPLETE line of U-gage manometers for water, oil or mercury scales is now being put out by the Defender Automatic Regulator Company, St. Louis, Mo. The instrument shown at the left has a case of cast aluminum fitted with a $\frac{1}{4}$-in. bottom connection. This gage is suited for mounting on top of a gas or air line and may be turned in any direction for convenience of reading. This same model may be had with a $\frac{1}{4}$-in. back connection and with different scales. Red liquid is used in the tube against a white background.

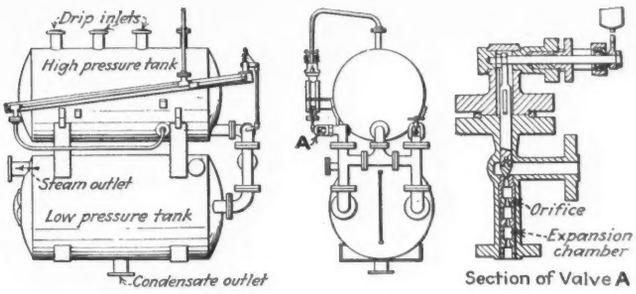
In the manometer shown in the right-hand view, the connection is made through street ells at the top, which can be turned up or down or to any direction desired. A needle bypass valve is built into the top for use when the gage reads differential pressure or flow. Mercury is used in the tube and a red line is painted on the back of the U-tube to facilitate reading the gage at a distance.



U-gage type manometers

Drain Control for High-Pressure Steam Mains

THE DRAIN CONTROL illustrated, put out by the Elliott Company, Jeanette, Pa., is designed to give continuous and automatic draining of high-pressure steam lines without the use of traps or other auxiliary equipment. The unit consists of a high-pressure and low-pressure receiver with two control valves interposed between the receivers, one valve being manually controlled and the other controlled by a thermostat mounted on the side of the receiver.



Arrangement of high- and low-pressure receivers with manually and thermostatically operated control valves

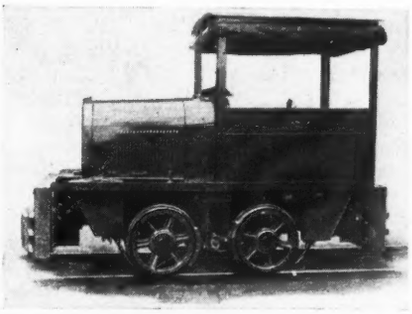
Drips from the high-pressure steam lines are led to the upper, or high-pressure, receiver, expanded to a lower pressure through special expansion control valves and collected in the low-pressure receiver. From this receiver the condensate is pumped or discharged to a heater, hotwell or other convenient point. A section of the control valves previously referred to is shown at the right of the illustration. In place of the usual single seat and disk valve, the pressure reduction is through a series of orifices and expansion chambers, consequently the pressure drop across the upper seat and disk is relatively small.

In operation the manually controlled valve is set to take care of the minimum flow, and the fluctuations are handled by a thermostatically controlled valve *A*.

The high-pressure receiver is of hammer-weld steel pipe with bumped head, the construction being similar to that used on "Welderon" receiver separators put out by the same company. The drain control is built for three pressure standards, 250, 400 and 600 pounds.

Gasoline-Motor-Powered Industrial Locomotives

MADE in five sizes ranging from 2 to 4 tons' capacity, the new line of gasoline-engine-powered locomotives put out by the Brookville Locomotive Company, Brookville, Pa., is particularly suited to the handling of ash-disposal cars in larger power plants, refineries, etc., and other haulage in the industrial field.

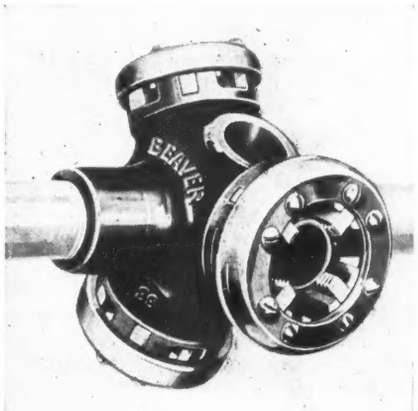


Type BFA-3 Ford-powered locomotive

The locomotive has a Ford AA power unit, including a heavy-duty single-disk clutch and four-speed truck transmission. All four forward speeds, giving 2 to 16 miles an hour, are available in reverse through either of two types of drive. Drive wheels are 20 in. in diameter, with 4-in. face and $1\frac{1}{8}$-in. flange. Renewable steel tires are supplied as standard equipment. Four-wheel drive through oversize roller chains and four-wheel brakes are additional features.

Three-Way Die Stock

LIGHT WEIGHT and perfect balance are claimed for the new Beaver three-way die stock recently introduced by the Borden Company, Warren, Ohio. The dies are driven by the solid body of the tool and large openings are provided for easy oiling and chip clearance. The die retaining ring, which fits over the end of the die holder, is of pressed steel and is held in place by six screws. Dies and die retaining rings are interchangeable with the No. 3 Beaver ratchet stock. The new stock is made in two sizes: No. 33 with a threading range of $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ in., and No. 34 with a range of $\frac{1}{2}$, $\frac{3}{4}$ and 1 in.



Beaver No. 33 three-way die stock

NEWS of the FIELD

Spot News

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CONTRACT *to furnish power for the construction of Hoover Dam at Boulder Canyon, Colo., has been awarded to the Southern Sierras Power Company of Riverside, Calif., it was announced Oct. 15 at the Department of the Interior. Power will be transmitted from California and supplied at 2.009c. per kilowatt-hour, this price being based on a maximum demand of 10,000 kw. and a total usage of 100,000,000 kw.-hr. during the 5½-year construction period. The two other bids received from the Inland Utilities Company and the Southern Nevada Power Company called for erection of a temporary power plant near the dam site.*

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LAYING *of a natural gas pipe line from the Cutbank field of northern Montana to Spokane, Wash., in a project estimated at $50,000,000 to $75,000,000 is now being planned by capitalists of the Pacific Coast city.*

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PLANS *have just been approved by Fulham, one of London's largest boroughs, for the erection of a large steam-electric generating station at an estimated cost of $27,765,000. With an initial installation of 132,000 kw. and an ultimate capacity of 318,000 kw., the plant will supply many sections of the city.*

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THE LONGEST *carrier-current communication for regular operating service over power transmission lines has just been installed on the 110,000-volt, 445-mile line between New Orleans and Pine Bluff. Using General Electric equipment, it provides communication between New Orleans and Amite, La., Jackson and Indianola, Miss., and Pine Bluff, Ark.*

New-Process Wrought-Iron Mill Opened; Operation Requires 50,000 Hp. of Motors

ON OCT. 8 at Economy, Pa., the new $12,000,000 wrought-iron plant of the A. M. Byers Company was formally opened in the presence of several hundred industrial leaders. James J. Davis, Secretary of Labor and once an iron puddler, was the chief speaker. The program had an unusual significance in that it signalled the passing of hand-puddling. Just what this means is found in the fact that the plant using the new process can make more wrought iron in one month than was made in this country previously in one year.

The new process, developed by Dr. James Aston of Carnegie Institute of Technology, makes possible the application of steel mill machinery and methods to the manufacture of wrought iron. Pig iron is melted in cupolas and refined in Bessemer converters. This highly refined iron is poured into processing cups containing a bath of slag. The slag, which is of an exact composition, is prepared in an open-hearth furnace and tapped into the cups. As the molten iron falls through the liquid slag it solidifies into a granular form and, as in the hand-puddling furnace, each grain takes on a coating of slag. After sufficient iron has been poured into the cup, the surplus slag is poured off and a ball of iron similar in every respect to that taken from a hand-puddled furnace is left at the bottom of the cup, but it weighs about 8,000 lb. instead of 200.

From the processing cup the iron goes into a 950-ton press, where it is squeezed into an ingot. It is then rolled into shapes, much in the same manner as steel is rolled. The extent of the mechanical processes involved is indicated by the fact that about 50,000 hp. of motors is required to supply power.

All power is purchased at 22,000 volts and stepped down through four transformer banks to 6,600 volts, for which all the large alternating-current motors are designed. All the main drives, cranes and other applications requiring adjustable speed are driven by direct-current motors. The blooming mill is driven by a 5,000-hp. reversing motor supplied from two 2,200-kw. generators. The latter are driven by a 3,500-hp. wound-rotor induction motor with a heavy flywheel on its shaft. A 4,000-hp. direct-current motor drives the 46-in. plate mill and is supplied with power from two 2,200-kw. generators driven by a 6,000-hp. synchronous motor. On the 16-in. skelp mill there are three main direct-current motors totaling 7,000 hp., and the 10-in. mill is driven by three direct-current motors of 2,800 hp. total capacity. These motors take power from three motor-generator sets each consisting of a 2,800-kva. synchronous motor and a 2,000-kw. generator. Three 1,000-kw. motor-generators supply direct current to the cranes and adjustable-speed auxiliary motors. A 1,200- and a 350-hp. direct-current motor on the 900-ton electric press take power from a 1,500-hp. motor-generator set. Three 8,000-g.p.m. pumps are each driven by 500-hp. motors, and two 25,000-c.f.m. air compressors are driven by 2,500-hp. synchronous motors. Two 5,048-sq.ft. boilers equipped with chain-grate stokers supply steam to the gas producers and for other purposes about the mill. The steam conditions are 150 lb. and 50 deg. superheat.

New Cunarder Will Have Largest Marine Turbines

Contract for a mammoth new Cunarder, in which the turbines will establish a world's record for size, has just been awarded to John Brown & Company, of Clydeside, England. It is announced that they will develop not less than 200,000 shaft horsepower under a full head of steam. They will thus eclipse the present largest known propelling plants now in existence, which are those of the United States aircraft carriers Lexington and Saratoga, each with a turbine-electric drive rated at 180,000 horsepower.

Among the great liners, the Cunarder Berengaria, of 52,226 tons gross, is the highest-powered vessel now afloat, with an output of 76,250 hp. for her steam turbines. In proportion to tonnage, however, the Mauretania, of 30,696 tons, has much greater engine power, since her turbine machinery develops 75,000 hp.—a figure which has often been greatly exceeded.

Thanks to her machinery, of the latest design, and oil-burning water-tube boilers, working at a pressure which but

a few years ago would have been considered abnormally high, the new vessel promises to be the most economical steamer afloat. A steady sea speed of not less than 29 knots, which when necessary can be increased to 30 or even 32 knots, is anticipated on the basis of tank experiments with wax models of the projected ship.

It is almost certain that the giant turbines for the new Cunarder will be manufactured by C. A. Parsons & Company, Ltd.

Arizona Wins Right to File Suit Against Boulder Act

The first stage in Arizona's long-threatened suit to challenge the legality of the act creating the Hoover Dam, in Boulder Canyon, was approved by the United States Supreme Court on Oct. 13 when a bill of complaint directed against the other six Colorado Basin states and the Secretary of the Interior was permitted to be filed. The other states and the Secretary of the Interior will be served with a notice of the bill of complaint and will be allowed until Jan. 5 to file their answers.

In its bill of complaint Arizona contends that the project violates its rights, and asks that a permanent injunction be issued. It is contended that the project is unconstitutional, and five reasons are given to substantiate this claim. Among other reasons, it is stated that by authorizing the Secretary of the Interior on behalf of the United States to engage in the business of generating and selling electric power the project deprives Arizona of its right to collect taxes from other persons or corporations.

On the same date Comptroller General McCarl dismissed Arizona's contention that the initial appropriation of $10,660,000 for commencing construction should be held up because of the alleged inability of the city of Los Angeles and the Metropolitan Water District of Southern California to make the contracts for power and water. The validity of these contracts previously had been upheld by Attorney General Mitchell.

New 65,000-Kw. Unit Added to Waukegan Station

Turbine-generator unit No. 4 has just been put into service at the Waukegan station of the Public Service Company of Northern Illinois, the largest power house of that company. It is an Allis-Chalmers machine, rated at 65,000 kw. and brings the total station capacity to 175,000 kw. Three boilers installed with it will burn pulverized coal, two of them being standard type and the third having a dual purpose—to reheat steam from the turbine and to generate live steam in a separate section.

The initial steam pressure of the new unit is 600 lb. at 725 deg. F.

DETROIT DEDICATES POWER STATION

UNVEILING of a bronze tablet to the memory of Frank R. Mistersky on Oct. 7 marked the formal completion of Detroit's 80,000-kw. municipal power plant.

At the time of his death last January, Mr. Mistersky had completed 21 years as general superintendent of the city's Public Lighting Commission. By resolution the City Council changed the name of the plant from Morrell Street Station to Mistersky Station, and the unveiling completed this official act.

Mayor Murphy, John C. Nagel, president of the council, and William F. Zabriskie, president of the lighting commission, spoke at the services, which were followed by an inspection of the plant. The accompanying illustration shows the Mayor, members of the council and commission, and as guests of honor, relatives of Mr. Mistersky. The tablet was unveiled by a seven-year-old granddaughter.

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First Units of Sayreville Plant Go Into Service

An important addition to generating-plant capacity on the Atlantic Coast has just been placed in operation as part of the Utilities Power & Light System, its subsidiary, the Eastern New Jersey Power Company, having started up two 30,000-kw. units of what eventually will be a 180,000-kw. station on the Raritan River at Sayreville, N. J. The new plant is tied in with two properties serving adjacent territory, thereby providing for an interchange of power and insurance against loss of service.

Los Angeles Seeks Permit to Develop 136,000 Hp.

A preliminary permit for a 136,000-hp. power project on the Colorado River has been asked of the Federal Power Commission by the Metropolitan Water District of Southern California, Los Angeles. Power would be used for pumping water through a projected aqueduct from the Colorado River to the southern California coastal plain to be used for domestic and municipal purposes.

The contemplated development would include a diversion dam a mile and a half below the mouth of Bill Williams River, a tunnel, and power house with an installed capacity of 136,000 hp.

News of Canada

Ontario buys Dominion Power—Add to Moosejaw steam plant—Start work at Cora Lyn Falls

A SUM of $21,000,000 in bonds has just been paid by the Ontario Hydro-Electric Commission for the assets, franchise and rights of the Dominion Power & Transmission Company, Ltd., and its subsidiaries, of Hamilton, Ont. By the terms of the purchase the commission acquires many subsidiary companies, including street railway and bus lines, and several important power contracts for the supply of electricity to municipalities in Ontario and to industries extending from Port Colborne to Brantford.

The main source of the company's power supply is from a 50,000-hp. hydro-electric plant at Decew Falls, St. Catherines, where water is taken from the Welland Ship Canal. A 25,000-hp. steam plant at Hamilton supplements the hydro supply. Also, a long-term agreement exists for the purchase of 10,000 hp. from the Canadian Niagara Power Company at Niagara Falls.

TWO NEW BUILDINGS are now being erected by the National Light & Power Company, Ltd., at Moosejaw, Sask. One of these buildings is an addition to the turbine room at the company's power plant. This itself will

be 53x35 ft., and 28 ft. high on a concrete basement. A new 10,000-kw. turbine-generator has been ordered from Parsons Company of England for installation in this building. The other building is to be 32x71 ft. in size and one story high, and will house plant, offices and store departments.

CONSTRUCTION of two cofferdams required in connection with the erection of a power plant at Cora Lyn Falls, B. C., will be undertaken immediately by the West Kootenay Power & Light Company in order to take full advantage of the low water in the Kootenay River. Harnessing of the Cora Lyn Falls to yield a capacity of about 30,000 hp. will require about two years, according to company officials. This addition will bring the company's capacity on the Kootenay River to 197,000 horsepower.

Obituary

ARTHUR REED MCMAHAN, secretary and treasurer of the Troy Engine & Machine Company, Troy, N. Y., died Sept. 15 after an illness of several months duration. Born in Troy in 1882, Mr. McMahan was graduated from the local high school in 1900 and spent two years at Gettysburg College before becoming associated with the Troy Engine & Machine Company. He was active in the civic affairs of his native city and a prominent member of its social organizations.

How's Business?

BUSINESS is bearing up as well as can be expected under the weight of the wave of uncontrolled deflation which financial fatalism and lack of business statesmanship in this country let loose upon the world in the third quarter. Signs multiply indicating that business as a whole is not getting worse and is making definite improvement—too slow to warrant any high hopes of quick recovery this year, but steady enough to justify those looking and planning ahead for next year. Our index has risen again, for the fifth consecutive week, from 87.1% to 87.5% of normal, reflecting chiefly continued expansion in general trade and a level of building sustained above seasonal expectations. Increased consumption of electric power in manufacturing during September with some gain in employment and payrolls, indicate a fair seasonal resumption of industrial activity. A further rise in foreign trade in September offers some encouragement in face of increased uncertainties abroad.—*The Business Week*, Oct. 22.

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WHERE TO LUNCH

Really smart engineers are lunching in boilers these days. Here is a representative group at a recent luncheon given in New York City by Walter Kidde Constructors, Inc., to celebrate the completion of the Kleinert Rubber Company's new boiler, which produces 50,000 lb. of steam per hour. The fact that the stokers were started before the guests departed did not disturb them, since red confetti was used for coal. The boiler was deserted, however, soon after the soot blowers were turned on

Personals

COL. JOHN P. HOGAN, of Parsons, Klapp, Brinckerhoff & Douglas, consulting engineers of New York City, and DR. JOHN BAUER, statistician and public utility rate expert, have just been appointed by the St. Lawrence Power Development Commission of New York to act as advisors on technical problems of marketing and distributing power that may be developed on the St. Lawrence River.

DR. ADDAMS S. MCALLISTER has been appointed assistant director in charge of commercial standardization of the United States Bureau of Standards according to an announcement made by DR. GEORGE K. BURGESS, director of the bureau. Dr. McAllister was formerly editor of the *Electrical World* and was closely associated with the organization and early work of the American Engineering Standards Committee, now the American Standards Association. His appointment fills a vacancy created by the resignation of RAY M. HUDSON last December.

D. S. WEGG, formerly connected with the American Cyanamid Company, is now chief engineer of Consolidated Laundries of New York City.

DR. SCOTT TURNER, director of the United States Bureau of Mines, was honored recently for achievement in engineering by his Alma Mater, the University of Michigan. Upon this occasion he received the only degree of Doctor of Engineering conferred this year by the university.

DR. VLADIMIR KARAPETOFF, professor of electrical engineering at Cornell University, has been appointed visiting professor at the Polytechnic Institute of Brooklyn. Dr. Karapetoff will conduct a seminar in contemporary advances in electrical engineering.

FAY SMITH, assistant general manager and chief engineer of the Nebraska Power Company, in addition to his duties of supervising the engineering, construction and distribution departments of the company, now has general supervision of the generating station. R. C. GEPPERT, formerly assistant general superintendent of the same company, has been promoted to the rank of general superintendent, in which position he will have charge of the merchandise, transportation, accident prevention and claim departments of the company.

H. W. HOUGH has been appointed associate general manager of the Cleveland Electric Illuminating Company to succeed C. L. STONE, who resigned resigned recently at the end of 32 years in the electric industry. Mr. Hough has been connected with the Cleveland company for 20 years. He first engaged in research work and in 1923 was made assistant to the president.

Business Notes

PALMER-BEE COMPANY, Detroit, Mich., announces the opening of the following district offices: Room 333, Ellicott Sq. Bldg., Buffalo, N. Y., C. E. Jeremias, district manager; Room 508, Farmers Bank Bldg., 5th Ave. and Wood St., Pittsburgh, Pa., C. E. Musselman, district manager; Room 1056, Rockefeller Bldg., Cleveland, Ohio, F. B. Barkwill, district manager; Room 1210, Reynolds Bldg., Winston-Salem, N. C., E. S. Davidson, district manager; Bulletin Bldg., Philadelphia, Pa., S. T. Transeau, district manager.

UTILITIES EQUIPMENT CORPORATION, 110-120 North Alameda St., Los Angeles, Calif., has announced that Jones-Lyman & Company, and the Utilities Equipment Corporation, have consolidated and will operate under the name Utilities Equipment Corporation, Ltd., exclusively.

CHAIN BELT COMPANY, Milwaukee, Wis., announces the appointment of two new distributors in the construction equipment field, namely: Alabama Machinery & Supply Company of Montgomery, Ala., and Concrete Products Sales Company, Ltd., of Oakland, Calif.

GENERAL WATER TREATMENT CORPORATION has just been organized under Delaware laws as a holding company to merge the interests of the Permutit Company of New York City and the Ward-Love Pump Corporation of Chicago. W. Spencer Robertson, president of the Permutit Company, will be president of the new corporation, and Francis N. Bard, president of the Ward-Love company, will be chairman of its board.

ROSS MECHANICAL SUPPLY COMPANY, Pittsburgh, Pa., announces that J. F. Hallowell, formerly manager of sales of the Fisher Governor Company, is now in charge of its sales engineering.

AMERICAN HOIST & DERRICK COMPANY, St. Paul, Minn., announces that J. T. Conners, formerly Detroit district manager of the Thew Shovel Company, is now in charge of its "American Gopher" sales in the field. The company also announces the removal of its Dayton office to 703 New City Trust Bldg., Indianapolis, Ind. I. R. Bailey and W. M. Schoen, who have been stationed at Indianapolis for many years, will be located at the new office.

CUTLER-HAMMER, INC., Milwaukee, Wis., announces the appointment of B. L. Donahue as manager of its Buffalo district office, to succeed B. A. Hansen who has resigned.

LECOURTENAY COMPANY, Newark, N. J., announces the appointment of F. J. Moran as Philadelphia district manager with offices in the Witherspoon Building. Mr. Moran for the past fifteen years has been engaged in sales work for the General Electric Company in Philadelphia.

Coming Conventions

American Society of Mechanical Engineers. National Wood Industries Division. Meeting at the Hotel Pennsylvania, New York City, Oct. 16-17. Annual meeting in New York City, Dec. 1-5. National Fuels Meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Engineering Council. Administrative board meeting at the Mayflower Hotel, Washington, D. C., Oct. 17-18. Secretary, L. W. Wallace, 26 Jackson Pl., Washington, D. C.

American Institute of Electrical Engineers. District meeting at Louisville, Ky., Nov. 19-22. Annual Winter convention in New York City, Jan. 26-30, 1931. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Annual meeting at the Hotel New Yorker, New York City, Dec. 3-6. Secretary, David L. Fiske, 37 West 39th St., New York City.

International Acetylene Association. Annual convention at the Congress Hotel, Chicago, Ill., Nov. 12-14. Secretary, A. C. Morrison, 30 East 42nd St., New York City.

Midwest Power Engineering Conference and Exposition. Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Power Show. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

Stoker Manufacturers Association. Fall meeting at the Homestead, Hot Springs, Va., Nov. 3-5. Secretary, William V. McAllister, Foot of Walker St., Detroit, Mich.

Trade Catalogs

MOTORS — Bulletin 1150 illustrating and describing "Hytork" synchronous motors for industrial applications, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

ELEVATORS—Bulletin describing the "Rotoscope," a device for improving elevator service, Elevator Supplies Company, Hoboken, N. J.

MOTOR DRIVES—Data Book No. 78 on stock chain drives for ¼- to 75-hp. installations, Diamond Chain & Manufacturing Company, Indianapolis, Ind.

STEAM TURBINES—Bulletin, "A Pioneer in High Pressure Steam," telling of the work done by De Laval in developing high-pressure turbines, De Laval Steam Turbine Company, Trenton, N. J.

VALVES—Bulletin 8-R describing pressure-reducing valves for steam lines in power and industrial plants, Schutte & Koerting Company, 12th and Thompson Sts., Philadelphia, Pa.

PUMPS—Leaflet L-20426 describing single-stage condensate pumps for low operating heads, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

INSTRUMENTS — Illustrated 48-page pocket-size booklet entitled, "The Manometer and Its Uses," The Meriam Company, 1955 West 112th St., Cleveland, Ohio.

Fuel Prices

FUEL OIL

New York—Oct. 16, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.5c.@5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c.@6.25c. per gal.

St. Louis—Oct. 6, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.445 per bbl.; 28@30 deg., $1.595 per bbl.; 30@32 deg., $1.695 per bbl.; 32@36 deg., gas oil, 4.026c. per gal.; 38@40 deg., distillate, 4.651c. per gal.

Pittsburgh — Oct. 7, f.o.b. local refinery, 34@36 deg., fuel oil, 3.87½c.@4c. per gal.; 36@40 deg., 3.75c.@4c.

Philadelphia — Oct. 1, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — Oct. 7, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Oct. 4, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 80c. per bbl.; 30@32 deg., 90c.@95c. per bbl.

Boston—Oct. 11, tank-car lots, f.o.b., 12@14 deg., Baumé, 3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Oct. 11, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.75 @$2.00
Pool 10, hr.gr. low-vol.	New York	1.60 @ 1.75
Pool 11, low-vol.	New York	1.50 @ 1.75
Smokeless, mine-run	Chicago	1.75 @ 2.25
Smokeless, slack	Chicago	.50 @ 1.50
Harlan, Ky., slack	Chicago	.50 @ .90
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.20 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.50 @ 1.60
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	.85 @ 1.25
W. Ky., slack	Louisville	.25 @ .50
Pittsburgh, mine-run	Pittsburgh	1.30 @ 1.60
Smokeless, mine-run	Cincinnati	1.75 @ 2.25
Smokeless, slack	Cincinnati	1.00 @ 1.35
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, slack	Cincinnati	.65 @ 1.00

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.00@$3.35
Barley	New York	1.15@ 1.50

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Agnews—Dept. of Public Works, Sacramento, will receive bids until Nov. 4 for a group of buildings including ward, kitchen and steam heating plant for State Hospital here. Estimated cost $300,000. G. B. McDougall, Public Works Bldg., Sacramento, is state architect.

Calif., Modesto—Modesto Irrigation District, will build a sub-station at California St. and Stone Ave. Estimated cost $20,000. Work will be done by district forces under the supervision of B. W. Creim, ch. electrical engineer.

Conn., Hartford—Hartford Electric Light Co., 266 Pearl St., awarded contract for a 1 story, 25 x 30 ft. power sub-station on Park Rd. to Industrial Construction Co., 721 Main St. Estimated cost $40,000.

Conn., Storrs—Connecticut Agricultural College, C. C. McCracken, Pres., plans entire renovation of college heating system including central heating plant and new distribution. Estimated cost $400,000. Engineer not selected.

Ga., Elberton—Constitutional amendment to allow City to issue bonds to be voted at Nov. 4, election for the construction of a hydro-electric plant. H. S. Jandon Engineering Co., Elberton, are engineers.

Ill., Colchester—City plans an election Oct. 28 to vote $70,000 bonds for waterworks improvements including well, pump house, two centrifugal pumps, etc. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., are engineers.

Ind., Gary—School Commissioners, will receive until Oct. 28 for the construction of a school building including boiler room, etc. Estimated cost $1,000,000. W. B. Ittner, 911 Locust St., St. Louis, Mo., is architect.

Kan., Topeka — Atchison, Topeka & Santa Fe. Ry., is having revised plans prepared for a 50 x 51 ft. addition to boiler house $22,000. H. W. Wagner, Topeka, is chief engineer, Eastern lines.

Ky., Lexington—Lexington Water Co., M. S. Cramer, V. Pres. and Gen. Mgr., awarded contract for waterworks including 6¼ mi. pipe line to Kentucky River, also two pumping stations, to Louis des Cognets Co., Lexington.

La., Colfax—City plans an election Nov. 18 to vote $25,000 bonds for waterworks and $40,000 for light and power plant.

La., Lake Charles—Magnolia Ice Co., Beaumont, Tex., will soon receive bids for the construction of a 45 ton ice plant here. Estimated cost $45,000. A. J. Alexander, Beaumont, Tex., is engineer.

Mass., Boston—Beacon Laundry Co., 14 Lenox St., is receiving bids for a 1 story addition to boiler house. C. T. Main Co., 201 Devonshire St., is engineer.

Mass., Boston—Edison Electric Illuminating Co., 30 Boylston St., awarded contract for alterations to electric sub-station including two rotary converters at 484 Atlantic Ave. to Engineering Construction Co., 6 Beacon St. Estimated cost $40,000.

Minn., Plooming Prairie — City will receive bids until Oct. 24 for the construction of a municipal light, heat and power plant, including power house, Diesel generating equipment, and electric distribution system. Estimated cost $35,000. Bond issue to be voted Nov. 12.

Minn., Thief River Falls—City, P. C. Pederson, Clk., awarded contract for a power house including 35 kw. motor driven exciter set and switchboard, 20,000 gal. fuel oil storage tank, 750 b.p.h. to Dickinson Construction Co., Bemidji. Estimated cost $80,000.

Mo., Osage—Missouri State Prison, c/o F. B. Jones, Dir. of Penal Institutions, Jefferson City, is constructing a group of buildings, including dormitories, administration building, boiler house, kitchen, shops, etc., near here by convict labor.

N. J., Trenton—Dept., of Institutions & Agencies, State Office Bldg., will soon award contract for the construction of a power house at New Jersey State Prison. Estimated cost $40,000. C. N. Leathem, Jr., Div. of Arch. and Const., State Office Bldg., is engineer.

N. Y., Mount Vernon—Westchester County Sanitary Sewer Commission, E. S. Martin, Secy., Court House Annex, White Plains, will receive bids until Nov. 7 for Hutchinson project pumping plant here.

N. C., Kinston — City, J. E. Weyher, 210 West Lenoir St., Supt. of Water & Light Dept., will soon award contract for the construction of a power plant. W. C. Olsen, 405 Raleigh Building & Loan Bldg., Raleigh, is consulting engineer.

O., Berea—Bd. of Public Affairs, T. R. Barnum, Pres., plans extensions to electric light plant including additional generator set. Estimated cost $50,000. C. W. Root, Society for Savings Bldg., Cleveland, is engineer.

Okla., Fairfax—City is having preliminary plans prepared for the construction of a municipal electric light plant. Estimated cost $50,000. Private plans.

Pa., Ridgway—Borough of Ridgway, G. F. Greiner, Secy., plans an election Nov. 4 to vote bonds for reconstructing impounding dam and installing new pump, mains, etc., also extensions and improvements to waterworks. C. Gifford, is borough engineer.

Pa., Tarentum—City, L. R. Conroy, Secy., Boro Bldg., awarded contract for furnishing, installing and testing a 1,000 kw. power factor, 2,300 v. turbine driven alternator, complete with surface condenser and appurtenances; 50 kw. 125 v. combined steam electric driven exciter set and necessary electric wiring and switchboard alterations and additions to Elliott Co., Frick Bldg., Pittsburgh; 422 hp. water tube boiler superheater stoker blower, soot blower complete with setting automatic damper and feed water regulator flue and all auxiliaries to Babcock-Wilcox Co., Koppers Bldg., Pittsburgh, in connection with electric light plant. $150,000.

R. I., Providence—Narragansett Electric Co., Old Industrial Trust Bldg., awarded contract for a 3 story, 35 x 40 ft. sub-station to New England Power & Construction Co., Harris Ave. Estimated cost including equipment $40,000.

Tex., Taylor—A. C. Clausnitzer, New Braunfels, Tex., is having preliminary plans prepared for the construction of an ice plant at Second and Kimbro Sts.

B. C., Rossland — West Kootney Power & Light Co., is having plans prepared for the construction of a hydro-electric dam 400 ft. high on the Pend Oreille River instead of two dams as first proposed. Estimated cost $3,000,000 including power house. L. A. Campbell is engineer.

B. C., West Vancouver — Municipality of West Vancouver, is having plans prepared for improvements to waterworks including automatic pump, mains, etc. Estimated cost $165,000. J. Duncan, Municipal Hall, is engineer.

Ont., Toronto — Syndicate, c/o Chapman & Oxley, Sterling Tower, is having sketches made for the construction of British Empire Trade building including steam heating system, elevator, etc. on Fleet St. Estimated cost $500,000 to $1,000,000

Equipment Wanted

Engines, Generator, Etc.—Detroit Mich.—Wayne County, Bd. of Auditors, County Bldg., W. Gutman, Secy., is receiving bids for two engines and generators, mechanical equipment and electrical equipment for Wayne County Detention Home, Forest Ave. and Rivard St. Estimated cost $25,000.

Pump—College Station, Tex.—A. & M. College of Texas, c/o B. D. Marburger, Supt. of Utilities, is receiving bids for a 1,000 g.p.m. motor diven centrifugal pump for water supply.

Pump—Yankton, S. D.—City plans to purchase pump for waterworks. $1,700 authorized.

Pump—Orillia, Ont.—City Council, plans the installation of a pump in connection with proposed drain 1¼ mi. from Mississaga St. to Lake Simcoe. $100,000.

Pumping Unit — Brownwood, Tex. — Brownwood County Water Improvement District, will receive bids Until Nov. 6, for pumping unit, etc. for proposed irrigation and municipal water supply. Estimated cost $2,000,000.

Industrial Projects

Calif., Emeryville—Westinghouse Electric Co., Powell St., is receiving bids for a 1 story addition to factory. Estimated cost $25,000. Private plans.

Calif., Fresno—Sunland Sulphur Co., J. H. Wright, Supt., 2148 Inyo St., is having plans prepared for the construction of a sulphur mill. Estimated cost $75,000.

Calif., Los Angeles—Oliver Furniture Equipment Sales Co., West 11th St., awarded contract for a 120 x 153 ft. plant, 76 x 120 ft. warehouse and 40 x 120 ft. parts department, all 1 story to Austin Co. of California, 777 East Washington St. Estimated cost $50,000.

Calif., San Francisco — Stella Bros., 1470 Howard St., manufacturers of caskets, are receiving bids for the construction of a 3 story factory building. Estimated cost $50,000.

Colo., Pueblo—International Rubber Co., c/o R. C. Sudbury, Maine Hotel, has work under way on first unit of factory for the manufacture of garden hose, inner tubes, fan belts and other rubber products. Total cost $200,000.

Ind., Wabash—Rock Insulator Co., is having plans prepared for a 74 x 160 ft. factory for the manufacture of rock wool for all types of insulation. Estimated cost $50,000. Private plans. Machinery and equipment will be required.

Okla., Chickasha—Chickasha Cotton Oil Co., awarded contract for a 3 story, 53 x 119 ft. cotton oil refinery to W. E. Edmiston, Chickasha.

Okla., Oklahoma City — Century Petroleum Co., Braniff Bldg., plans the construction of a 3,500 bbl. oil refinery at 1800 East 4th St. Estimated cost $75,000. Private plans.

O., Cleveland—Powerlite Switchboard Co., J. F. Jirka, Secy. and Treas., 4149 East 79th St., is having plans prepared for a 1 and 2 story, 50 x 122 ft. addition to factory and office. Estimated cost $50,000. H. K. Ferguson Co., Hanna Bldg., is architect.

Pa., Neville Island—Gulf Refining Co., Frick Bldg., Pittsburgh, awarded contract for third and last unit of $1,500,000 project. Plans include 24 x 113 ft. transfer pump house, 34 x 107 ft. treating plant pump house, 25 x 32 ft. accumulation building, 42 x 62 ft. compressor building, 61 x 79 ft. hot oil pump house, 18 x 25 ft. acid concentrator building, 46 x 65 ft. caustic plant, 30 x 35 ft. dye house and dye sulphur and clay storage, 16 x 22 ft. casinghead pump house here to Landau Bros. Contracting Co., 125 First Ave., Pittsburgh.

Pa., New Castle—Blair Strip Steel Co., G. D. Blair, Jr., Pres., Butler Ave. Ext., plans to rebuild steel plant destroyed by fire. Estimated cost $500,000. Engineer not selected. Maturity probably in November.

R. I., Saylesville — Sayles Finishing Plants Inc., c/o Lockwood, Greene Engineers Inc., 24 Federal St., Boston, Mass., Engrs., will soon award contract for 1, 2 and 4 story, 30 x 40, 45 x 130, 65 x 70 and 15 x 55 ft. additions to plant including bleachery. Estimated cost to exceed $40,000.

Tex., Luling—Magnolia Petroleum Co., 1009 Fannin St., plans enlargement of present refinery for gasoline, kerosene, gas fuel and fuel oils. Hot oil units will be installed. Estimated cost $110,000. Work will be done by day labor.

Wis., Milwaukee — Filer & Stowell, 219 Bleeker St., (iron works) awarded contract for a 3 story, 70 x 81 ft. factory, to Meredith Bros., 253 Washington St.

Ont., Brockville—Eugene F. Phillips Electrical Co. Ltd., Kingston Rd., awarded contract for addition to electric wire plant including new electrical shop, machine shop, boiler house, rubber room ,brading room, finishing shop, etc. to C. E. Deakin, 1440 St. Catherine St. W., Montreal, Que. Estimated cost $500,000.

Ont., New Toronto—Anaconda American Brass Co. Ltd., plans the construction of a 1 story, 80 x 400 ft. copper and brass tube mill. Estimated cost $100,000. Private plans.

Que., Hull — E. B. Eddy Co. Ltd., C. V. Caeser, Gen. Mgr., is having plans prepared for first unit of bleaching plant and water filtration plant. Estimated cost $1,800,000. Private plans.